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This study provides information on four hypothetical refineries for the purpose of modeling ambient benzene dispersion. Information given for each refinery is: a plot plan mapping the location of modules; an estimate of the number and size of potential emission points in each module including pumps and compressors, valves and fittings, heaters or boilers, tanks, wastewater treatment facilities, cooling towers, and flares; and a list of significantly tall or wide structures in each module. The hypothetical refineries span the range of operating capacities of refineries found in the United States.

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OBJECTIVES

The objectives of this work assignment are to place representative process units, tankages, auxiliary equipment, and structures frequently found in refineries into modules and then to locate these modules on refinery plot plans for the purpose of generating hydrocarbon ambient dispersion models. In specific, to establish a basis for calculating hydrocarbon emissions -- including benzene, information is provided for four hypothetical refineries. The information required for the calculation consists of:

1. A plot plan of each refinery mapping the location and area of appropriate modules
2. An estimate of the number and size of potential emission points in each module including pumps and compressors, valves and fittings, heaters or boilers, tanks and reservoirs, wastewater treatment facilities, cooling towers and flares
3. A list of tall and wide structures in each module which could affect airflow and thereby hydrocarbon dispersion

DESCRIPTION OF REFINERY CASES

Four refinery cases are detailed in the report. Each case corresponds to a refinery category named in the work assignment. The four cases together span the capacities and ages of presently operating refineries. Each refinery case includes an aromatics recovery process. The four cases developed are:

1. A small capacity existing refinery with a crude unit charge rate of 8,000 m^3/day
2. An intermediate capacity existing refinery with a crude unit charge rate of 32,000 m^3/day
3. A large capacity existing refinery with a crude unit charge rate of 56,000 m^3/day
4. A relatively new refinery with a crude unit charge rate of 40,000 m^3/day

SUMMARY

The following table summarizes the number of points from which hydrocarbons may be emitted for each refinery case

	Small Existing Refinery	Intermediate Existing Refinery	Large Existing Refinery	New Refinery
Pumps - active and spare in hydrocarbon service	186	411	614	315
Compressors - active and spare in hydrocarbon service	17	37	61	24
Pumps and compressors - active and spare in aqueous service	30	43	53	25
Control valves	228	364	809	352
Process valves	16,645	28,240	48,670	24,805
Fittings	54,706	94,867	162,996	83,337
Relief valves	237	429	739	371
Sample fittings	323	634	997	495
Combustion devices	29	49	91	32
Tanks	78	416	236	70
Flares	2	4	3	2

APPROACH FOR DEVELOPING THE REFINERY CASES AND THE LISTINGS OF POTENTIAL EMISSION POINTS

A refinery is conceptualized as an aggregation of modules that serve as the basis of a dispersion model calculation. Modules are three-dimensional volumes whose sides are defined by the perimeter of the module within the refinery and by an average module height. Three general types of modules appear in the four refineries: process modules, tankage modules, and modules with miscellaneous supportive functions.

A process module is the area on which a refinery unit transforms a feedstream to intermediate or final products. For example, in the catalytic reformer module, the feedstream, naphtha, is transformed into a liquid product, reformate; and gaseous by-products, butanes and lighter gases. The average module height for all process modules is 5 meters and roughly corresponds to the height of a pipe rack.

Tankage modules consist of land in the refinery on which storage vessels are placed to contain crude, intermediate products, or final products. The average module height for these modules is ground level.

Refining functions taking place in the remaining areas of the refinery may include bulk loading and unloading, flares, wastewater treatment facilities, boilers and incinerators, and vacant areas within the refinery. The average module height of these modules is ground level.

The hydrocarbon dispersion model predicts hydrocarbon concentrations outside the refinery boundary. Two distinct types of information regarding refinery modules are necessary to make this calculation. The first relates to the area allocated to the module and to the placement of the module inside the refinery boundaries. The areas of the modules and the siting of the modules within the refinery were obtained from plot plans of operating refineries. To facilitate modeling, the shapes of the modules and the refineries were stylized as rectangular.

The second consists of itemizing the possible hydrocarbon emission points and the significantly large structures within the modules. For example, emission points in the catalytic reformer module include the pumps and compressors, valves and fittings, and process heaters associated with the reformer reactor section and the fractionating section. Tankage modules require a table to provide the information needed to calculate tank emissions.

To minimize repetition of equipment listings, the report is organized into five sections. Preceeding the refinery cases, standard process units were developed for frequently found processes. When these units appear in any of the refinery modules, the standard unit is referenced. However, there may be differences between the throughput listed for the standard unit and that listed for the refinery module. The normal operating range of the standard units may vary from 50 percent to 150 percent of the rated throughput without changing the emission point itemization. If there are significant differences between the standard unit and the refinery module, the correct values will be listed in the refinery module. These differences are mainly process heater design heat inputs.

Four refinery cases are developed after the standard unit descriptions in the report. For each refinery, a plot plan; a module key; and a page listing the crude charge, the product slate, and the appropriate number of wharf modules provide summary data. Following the summary data are the refinery module descriptions. Included here are the functional title of the module; the module area in hectares; a description of the inputs and outputs of the module; an emission point itemization; and, a large structure listing. A comparison of the refinery outputs with the crude charges indicates a net volumetric increase in each refinery case. This increase is due to input streams into the refinery which are not crude oil and to the addition of hydrogen into process streams.

EMISSION POINT ITEMIZATIONS

Equipment itemizations for each standard unit or refinery module were developed from engineering experience, from discussions with refiners, from available refinery inspection reports, and from literature sources such as the refining handbook edition of Hydrocarbon Processing. The data included in the report for standard units, process modules, and some miscellaneous modules are: the number of active and spare pumps and compressors and a classification of the Reid vapor pressure of the fluid being pumped; an estimate of the number of control, process, and relief valves; an estimate of the number of fittings; an estimate of the number of sampling connections; the number of process heaters and boilers and an estimate of the design heat input; and a listing of structures significantly large enough to affect airflow through the module. For tankage, the data included are: the material stored in the tank; type of seal on the tank; tank height and diameter; and the annual throughput of the tank. Each type of emission point data is discussed in detail below.

Pumps and Compressors

The number of active and spare pumps and compressors was determined either by counting pumps on actual process flow diagrams or by estimating the number from the process flow diagrams provided in the Hydrocarbon Processing refining handbook. The number of spare pumps was estimated from engineering judgement when the actual number was not known. In the report, the Reid vapor pressure of the fluid pumped was listed in one of the following ranges:

RVP CATEGORY	RVP RANGE (kPa)
A	Greater than 180
B	180 - 34.5
C	34.5 - 3.4
D	Less 3.4

Additionally, a pump is designated, C, if the pump is centrifugal type; R, is the pump is a reciprocating type. The type of pump seal is indicated by, M, for mechanical seals or by, P, for packed seals.

Valves and Fittings

The number of control valves either was counted on actual process flow diagrams or was estimated by comparing similar vessel types in processes where the actual number of control valves was known.

The number of process valves was prorated on the number of active and spare hydrocarbon pumps. Based on recent data provided by the EPA task manager, the number of process valves equaled 70 times the number of active and spare pumps. Inspections in Los Angeles area refineries have shown that 23.6 percent of the total number of these process valves are in gas service, with 78.8 percent of these gas service valves being 4cm or greater and 21.2 percent under 4cm. The remaining 76.4 percent of the process valves were in liquid service with 44.3 percent of these liquid service valves being 4cm or greater.

The total number of fittings reported in the standard units and refinery modules include both flanged and screwed fittings. This figure was derived by multiplying the number of active and spare pumps handling hydrocarbons by 235. From the Los Angeles Air Pollution District Joint Report, 60 percent of the total are screwed fittings and the remaining 40 percent are flanged fittings.

The number of relief valves were determined in a manner similar to that used for estimating the number of control valves. Here, vessels and columns within the module were used as a basis for estimation.

The number of sampling connections in a unit or module was determined by summing the number of pumps, the number of heat exchangers, and the number of hydrocarbon streams flowing in and out of the module.

Combustion Devices

The number of process heaters and boilers, the design heat input for each device, and stack heights and diameters came from *Hydrocarbon Processing* process flow sheets and from several inspection reports of processing operations.

Structures

Structures and vessels greater than 9m in height or greater than 9m in diameter were listed for each module. The dimensions of these structures were estimated from engineering experience.

Tanks

The data recorded for each tank were: the stock held in the tank; an estimate of the Reid vapor pressure of the stock; notations for the type of roof - FR for floating roof, XR for fixed roof, P for pressure; the diameter and height of the tank; and an estimate of the annual throughput. The annual throughput was estimated at 13 times the tank capacity if the actual throughput was not known. No pumps or valve counts were listed with tanks as these emission points were inventoried in other units or modules.

STANDARD UNIT KEY

Standard Unit No.	Description
X1	Distillation and Gas Recovery
X2	Naphtha Hydrotreater
X3	Light Ends Recovery
X4	Catalytic Reformer
X5	Jet Hydrofiner
X6	Hydrotreater
X7	Hydrogen Manufacture
X8	Partial Oxidation-Hydrogen Manufacture
X9	Vacuum Gas Oil Unit
X10	Benzene Fractionation
X11	Steam Rerun Still
X12	Crude Distillation
X13	Catalytic Reformer
X14	Vacuum Residuum Desulfurizer
X15	Alkylation
X16	Propylene Polymer Plant
X17	LPG Plant
X18	Heavy Gas Oil Distillates Hydrodesulfizer
X19	Gas Oil Washer and Brightener
X20	Sulfur Recovery
X21	Absorption Section of Wellman-Lord tail gas clean-up unit
X22	Chemical section of Wellman-Lord tail gas clean-up unit.
X23	Sulfuric Acid Plant
X24	Catalytic Reformer
X25	Aromatics Extraction
X26	Catalytic Cracking Unit
X27	Para-Xylene Plant
X28	Delayed Coker Plant
X29	SO_2 Treating Plant
X30	Acid Treating Plant
X31	Gasoline Sweetening
X32	Crude Distillation
X33	Crude Desalting
X34	Specialty Crude Distillation
X35	Gasoline Fractionating
X36	Loading Rack Facility
X37	Vapor Recovery Plant
X38	Ship and Barge Loading Facility
X39	Gasoline Rectifier Plant

Standard Unit No.	Description
X40	Wastewater Treatment Facility
X41	Sour Water Oxidizer
X42	Solvent Decarbonizer
X43	Thermal Hydrodealkylation
X44	Naphtha Hydrodesulfurizer
X45	Refinery Stock Transfer Center
X46	Acid Gas Treating Plant
X47	Beavon-Stretford Sulfur Recovery Plant
X48	Alkylation
X49	Vacuum Distillation Unit

STANDARD UNIT NO. X1
DISTILLATION AND GAS RECOVERY UNIT
1.5 x 10^6 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
4	Absorption oil	2x	B	C	M
2	Propane	x	A	C	M
2	Butane	x	A	C	M
2	Gasoline product	x	B	C	M
2	Demeth. abs. btms.	x	C	C	M
2	Deeth. abs. btms.	x	C	C	M
4	Propane refrigerant	2x	A	C	P
4	Propane reflux	2x	A	C	M
2	Butane product		A	C	M
2	Propane product		A	C	M
4	Lean gaso	2x	C	C	M
2	Compressors	x	A	C	P

2. VALVES AND FITTINGS

a. Control Valves - 51

b. Process Valves - 3,220

c. Fittings - 10,800

d. Relief Valves - 56

e. Sample Connections - 63

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
2	H	51.7	33.5	1.8

STANDARD UNIT NO. X2
NAPHTHA HYDROTREATER
2,385 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Reactor bottoms	x	B	C	P
1	Stripper bottoms	x	B	C	M
1	Product pump	x	B	C	M
1	Product pump		B	C	M
1	Desulfurizer pump	x	B	C	M
1	Separator pump		B	C	M
1	Separator pump	x	B	C	M
1	Separator pump		B	C	M
1	Feed pump	x	B	C	M
1	Feed pump		B	C	M
1	Compressor	x	A	R	P
1	Compressor		A	R	P

2. VALVES AND FITTINGS

a. Control Valves - 19

b. Process Valves - 1,330

c. Fittings - 4,465

d. Relief Valves - 23

e. Sample Connections - 29

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	24.0	36.6	2.44
1	H	25.6	36.6	2.44

STANDARD UNIT NO. X3
LIGHT ENDS RECOVERY UNIT
85,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Feed gas compressor	x	A	R	P
1	Propane/Propylene	x	A	R	P
1	Liquid feed	x	B	C	M
1	Gasoline to storage	x	B	C	M
1	Butane/Butylene	x	B	C	M
1	Stabilizer gas compressor	x	A	C	M
1	Deethanizer bottoms	x	B	C	M

2. VALVES AND FITTINGS

a. Control Valves - 15

b. Process Valves - 1,050

c. Fittings - 3,525

d. Relief Valves - 18

e. Sample Connections - 19

STANDARD UNIT NO. X4
CATALYTIC REFORMER
4,800 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	B	C	M
1	Bottoms	x	B	C	M
1	Reboiler feed	x	B	R	P
1	Product	x	A	C	M
1	Recycle compressor		A	C	M
1	Booster compressor	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 16

b. Process Valves - 770

c. Fittings - 2585

d. Relief Valves - 12

e. Sample Connections - 18

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	81.7	27.4	1.13
1	H	87.0	27.4	1.13
1	H	79.1	27.4	1.13
1	H	15.8	27.4	1.13

STANDARD UNIT NO. X5
JET HYDROFINER
500 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	C	C	M
1	Reactor bottoms	x	C	C	M
1	LP separator	x	C	C	M
1	Recycle	x	C	R	P
1	Product	x	C	R	P
1	Recycle gas Compressor	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 12

b. Process Valves - 840

c. Fittings - 2,820

d. Relief Valves - 15

e. Sample Connections - 16

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	17.	31.*	1.4
1	H	12.	31.*	1.4

*Heaters share common stack

STANDARD UNIT NO. X6
HYDROTREATER UNIT
8,000 m^3/day fresh feed

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	H_2 compressor	x	A	R	P
1	Recycle compressor		A	C	P
1	Feed		C	C	M
1	Water injection		-	R	P
1	Debut. overhead		A	C	M
1	Fract. reflux	x	B	C	M
1	Debut reboiler	x	B	C	M
1	Fract. overhead	x	A	C	M
1	Naphtha	x	B	C	M
1	Kero.		C	C	M
1	Kero.	x	C	C	M
1	Hvy Distillate	x	D	C	M
1	Fract. Bottoms	x	D	C	M
1	Injection		—	R	P
1	Regeneration* Circulating		C	C	M

* Intermittent usage

2. VALVES AND FITTINGS

a. Control Valves - 64

b. Process Valves - 1610

c. Fittings - 5405

d. Relief Valves - 28

e. Sample Connections - 42

STANDARD UNIT NO. X6
HYDROTREATER UNIT
8,000 m^3/day fresh feed
(Concluded)

3. COMBUSTION DEVICES

A. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
2	H	71.3	33.5	2.0
1	H	308.1	55.0	3.9
1	H	185.7	40.0	3.1

STANDARD UNIT NO. X7
HYDROGEN MANUFACTURING UNIT
2,800,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Hydrogen Compressor	x	A	C	M
1	Hydrogen Compressor		A	C	M
1	Carbonate	x	D	C	M
1	Feed	x	B	C	M

2. VALVES AND FITTINGS

a. Control Valves - 37

b. Process Valves - 2,430

c. Fittings - 8,225

d. Relief Valves - 34

e. Sample Connections - 46

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1 (with 2 Stacks)	H	527.7	30.9	1.45
			30.9	2.4

STANDARD UNIT NO. X8
PARTIAL OXIDATION UNIT FOR HYDROGEN MANUFACTURE
85,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed pump	x	B	C	M
2	Compressors	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 10

b. Process Valves - 350

c. Fittings - 1,175

d. Relief valves - 12

e. Sample Connections - 16

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	58.6	31.0	4.1
1	H	83.0	40.5*	2.75
1	H	285	40.5*	2.75
1	B	95.5	31.0	1.5
1	B	74.4	33.5	2.1

*Heaters share common stack

STANDARD UNIT NO. X9
VACUUM GAS OIL UNIT
5,565 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Primary feed	x	C	C	M
1	Secondary feed	x	C	C	M
1	Reactor bottoms pump	x	C	C	M
1	Naphtha pump	x	B	C	M
1	Gas oil product pump	x	C	C	M
3	Separator pump	2x	C	C	M
2	Recycle gas compressor	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 20

b. Process Valves - 1,260

c. Fittings - 4,230

d. Relief Valves - 15

e. Sample Connections - 25

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	86.0	52.0	1.4
1	B	33.7	33.5	1.3

STANDARD UNIT NO. X10
BENZENE FRACTIONATION
800 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed to benzene/toluene column	x	C	C	M
1	Benzene product	x	C	C	M
1	Toluene produce	x	C	C	M
1	Feed to xylene column	x	D	C	M
1	Xylene product	x	D	C	M
1	Heavy aromatic product	x	D	C	M

2. VALVES AND FITTINGS

a. Control Valves - 10
b. Process Valves - 840
c. Fittings - 2,820
d. Relief Valves - 8
e. Sampling Connections - 12

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Heater or Boiler	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	90	30.5	1.8

STANDARD UNIT NO. X11
STEAM RERUN STILL
2,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	C	R	P
1	Fract. Btms.	x	D	C	P
1	Recycle		C	C	M
1	Stripper Btms.		D	R	P
1	Gas Oil Product	x	D	C	P

2. VALVES AND FITTINGS

   a. Control Valves - 12

   b. Process Valves - 560

   c. Fittings - 1,904

   d. Relief Valves - 12

   e. Sample Connections - 17

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	46.2	25.5	1.4

STANDARD UNIT NO. X12
CRUDE DISTILLATION UNIT
23,850 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Primary feed	x	C	C	M
2	Secondary feed	x	C	C	M
2	Vacuum heater charge	x	D	C	M
2	Vacuum column bottoms	x	D	C	M
2	Atmos. column reflux	x	B	C	M
2	Vacuum column reflux	x	C	C	M
1	First sidecut		B	C	M
1	Second sidecut		C	C	M
1	Third sidecut		C	C	M
1	Fourth sidecut		C	C	M
1	Fifth sidecut		D	C	M
1	Sixth sidecut		D	C	M
1	Rectifier reflux	x	B	C	M
1	Rectifier feed	x	B	C	M
1	Seventh sidecut		D	C	M
1	Vacuum net overhead	x	D	C	M
1	Light oil feedback	x	C	R	P
1	Heavy oil feedback	x	C	R	P
1	Oil from vacuum skimmer		C	R	P
1	Rectifier net overhead	x	B	R	P

2. VALVES AND FITTINGS

a. Control Valves - 40

b. Process Valves - 2,660

c. Fittings - 8,930

d. Relief Valves - 39

e. Sample Connections - 57

STANDARD UNIT NO. X12
CRUDE DISTILLATION UNIT
23,850 m^3/day
(Concluded)

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
2	H	216	51.8	4.0*
2	H	69	38.1	1.4*
2	H	52	38.1	1.3*

*Heaters share common stack

STANDARD UNIT NO. X13
CATALYTIC REFORMER
3,200 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	B	C	M
1	Bottoms	x	B	C	M
1	LPG		A	R	P
1	Reboiler feed		A	R	P
1	Product	x	B	C	M
1	Recycle compressor	x	A	C	M
1	Booster compressor		A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 16

b. Process Valves - 770

c. Fittings - 2,585

d. Relief Valves - 12

e. Sample Connections - 16

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	82.	27.4	1.1
1	H	87.	27.4	1.1
1	H	79.	27.4	1.1
1	H	16.	27.4	1.1

STANDARD UNIT NO. X14
VACUUM RESIDUUM DESULFURIZER
4,500 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	Feed	x	D	C	M
1	Product		D	C	M
2	Separator	x	C	C	M
2	Compressors		A	C	M

2. VALVES AND FITTINGS

   a. Control Valves - 14
   b. Process Valves - 770
   c. Fittings - 2,585
   d. Relief Valves - 13
   e. Sample Connections - 18

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
2	H	21.1	36.6	1.4
1	H	15.8	37.8	1.1

STANDARD UNIT NO. X15
H_2SO_4 ALKYLATION PLANT
800 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	Fresh acid	x	-	R	P
1	Butane/butylenes feed		A	C	M
1	Splitter		A	C	M
1	Splitter reflux	x	A	C	M
1	Splitter bottoms		B	C	M
1	Deisobutanizer feed		A	C	M
1	Deisobutanizer reflux	x	A	C	M
1	Deubutanizer reflux	x	A	C	M
1	Depropanizer reflux		A	C	M
1	Propane treater bottoms		A	C	M
1	Compressor condensate accumulator pump		A	C	M
1	Cold effluent pump		B	C	M
2	Butane/Butylenes and isobutane	x	A	R	P
1	Alkylate to storage	x	B	C	M
1	Compressor	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 36

b. Process Valves - 1,750

c. Fittings - 5,875

d. Relief Valves - 16

e. Sample Connections - 30

STANDARD UNIT NO. X15
H_2SO_4 ALKYLATION PLANT
800 m^3/day
(Concluded)

3. COMBUSTION DEVICES

A. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	80.	35.0	1.7

STANDARD UNIT NO. X16
PROPYLENE POLYMER PLANT
560 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Product to storage	x	B	C	M
1	Stabilizer feed	x	A	C	M
1	Stabilizer reflux	x	A	C	M
1	Fractionator reflux	x	B	C	M
2	Fractionator feed	x	B	C	M

2. VALVES AND FITTINGS

a. Control Valves - 15

b. Process Valves - 840

c. Fittings - 2,820

d. Relief Valves - 12

e. Sample Connections - 19

STANDARD UNIT NO. X17
LPG PLANT
400 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP CLass	Pump Type	Seal Type
1	Debutanizer OH feed to depropanizer		A	C	M
1	Debutanizer reflux	x	A	C	M
1	Liquid propane to storage	x	A	C	M
1	Deisobutanizer feed	x	A	C	M
1	Deisobutanizer reflux		A	C	M
1	Deisobutanizer bottoms to storage	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 10

b. Process Valves - 700

c. Fittings - 2,350

d. Relief Valves - 12

e. Sample Connections - 17

STANDARD UNIT NO. X18
HEAVY GAS OIL DISTILLATES HYDRODESULFURIZER
1,900 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	C	C	M
1	Product	x	D	C	M
2	Separator	x	C	C	M
2	Compressors	x	A	R	P

2. VALVES AND FITTINGS

   a. Control Valves - 10

   b. Process Valves - 700

   c. Fittings - 2,350

   d. Relief Valves - 12

   e. Sample Connections - 16

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	31.6	46.	1.2

STANDARD UNIT NO. X19
GAS OIL WASHER AND BRIGHTENER
1,500 m^3/day

1. PUMPS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	D	C	P
1	Water		-	C	P

2. VALVES AND FITTINGS

   a. Process Valves - 180

   b. Fittings - 470

NOTE: This unit is seldom used. New refineries would very probably not have a unit of this type. Early versions brightened with an air stream.

STANDARD UNIT NO. X20
SULFUR RECOVERY UNIT (2 STAGE CLAUS UNIT)
272 metric tons/day

1. PUMPS AND COMPRESSORS

No.	Service	Type
1	Sulfur transfer	Vertical, submerged

2. VALVES AND FITTINGS

   a. Control Valves - 4

   b. Process Valves - 150

   c. Fittings - 392

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Height (m)	Diameter (m)
1	H*	65.4	* * *	
2	H* *	34.8	* * *	

* Main reactor
* * Auxiliary start-up burners
* * * Gases vented to tail gas clean-up unit, Standard Units No. X21 and X22

STANDARD UNIT NO. X21
ABSORPTION SECTION OF A WELLMAN-LORD TAIL GAS CLEAN-UP UNIT

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Recycle quench water			C	P
1	$NaHSO_3$ Solution			C	P

2. VALVES AND FITTINGS

a. Process Valves - 95

b. Fittings - 264

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	52.8	45.7	1.7
1	H	44.0	46.0	2.5

STANDARD UNIT NO. X22
CHEMICAL SECTION OF A WELLMAN-LORD TAIL GAS CLEAN-UP UNIT

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Recycle quench water	x	-	C	P
1	$NaHSO_3$ solution	x	-	C	P
1	Na_2SO_3 slurry pump		-	C	P
1	H_2O recycle pump		-	C	P
1	Compressor	x	-	C	P

2. VALVES AND FITTINGS

A. Control Valves - 8

b. Process Valves - 420

c. Fittings - 1,410

d. Relief Valves - 7

e. Sample Connections - 12

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	O*	31.6	45.7	1.7
1	H	26.4	46.	1.7

* Thermal oxidizer

STANDARD UNIT NO. X23
SULFURIC ACID PLANT
182 metric tons/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Oleum	x	-	C	P
1	Sulfur feed		-	C	P
1	Absorbing acid	x	-	C	P
1	Drying acid		-	C	P

2. VALVES AND FITTINGS

   a. Control Valves - 8

   b. Process Valves - 490

   c. Fittings - 1,645

   d. Relief valves - 8

   e. Sample Connections - 15

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	SB*	31.7	1.8	7.0

* Sulfur burner

STANDARD UNIT NO. X24
CATALYTIC REFORMER
7,200 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
4	Reactor bottoms	x	C	C	M
1	Stripper bottoms	x	C	C	M
1	Product	x	B	C	M
1	Feed	x	B	C	M
2	Reflux	x	B	C	M
2	Separator	x	B	C	M
2	Recycle gas compressors	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 22

b. Process Valves - 1,470

c. Fittings - 4,935

d. Relief Valves - 18

e. Sample Connections - 30

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
4	H	139	33.5	1.8*

* Heaters share common stack

STANDARD UNIT NO. X25
AROMATIC EXTRACTION PLANT (SULFOLANE SOLVENT)
600 m^3/day Total Aromatics

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Extractor feed	x	B	C	M
1	Extractor reflux	x	B	C	M
1	Raffinate product		B	C	M
1	Raffinate water wash recycle	x	Aqueous	R	P
1	Water stripper tower charge	x	B	C	M
1	Bottoms-solvent recovery tower	x		R	P
1	Bottoms water stripper	x		R	P
1	Raffinate from water wash	x	C	C	M
1	Extract to fractionation	x	C	C	M
1	Feed to benzene/toluene column	x	C	C	M
1	Benzene product	x	C	C	M
1	Toluene product	x	C	C	M
1	Feed to xylene column	x	D	C	M
1	Xylene product	x	D	C	M
1	Heavy aromatic product	x	D	C	M

2. VALVES AND FITTINGS

a. Control Valves - 29

b. Process Valves - 2,030

c. Fittings - 6,815

d. Relief Valves - 34

e. Sampling Connections - 29

STANDARD UNIT NO. X25
AROMATIC EXTRACTION PLANT (SULFOLANE SOLVENT)
600 m^3/day Total Aromatics
(Concluded)

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Heater or Boiler	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diamater (m)
1	H	70	30.5	1.8

STANDARD UNIT NO. X26
FLUID CATALYTIC CRACKING UNIT
7,950 m^3/day

1. PUMPS AND COMPRESSORS

No.		Spare	RVP Class	Pump Type	Seal Type
3	Compressor	x	A	R	P
1	Debutanizer overhead	x	A	C	M
1	Fractionator top reflux	x	B	C	M
1	Fractionator 1st cut	x	B	C	M
2	Absorber feed	x	B	C	M
2	Absorber lean sponge	x	B	C	M
1	Stablizer bottoms		B	C	M
1	Stablizer reflux	x	B	C	M
1	Gasoline overhead		B	C	M
1	Intermediate reflux	x	C	C	M
4	Gas oil circulation	2x	D	C	M
1	Thick slurry		D	C	M
1	Clarified oil		D	C	M
2	Slurry return to feed	x	D	C	M
3	Slurry recycle to fractionator	x	D	C	M
1	Hydraulic oil	x	D	R	P
1	Gas oil	x	D	C	M

2. VALVES AND FITTINGS

a. Control Valves - 35

b. Process Valves - 2,870

c. Fittings - 9,635

d. Relief Valves - 18

e. Sample Connections - 67

3. COMBUSTION DEVICES

Service	Design Heat Input (GJ/hr)	Stack Height(m)	Stack Diameter(m)
Feed preheater*	79.1	42.6	2.0
Regenerator startup heater*	69.9		
CO boiler	614	42.7	4.3

*Feed preheater and regenerator start-up heater share common stack

STANDARD UNIT NO. X26
FLUID CATALYTIC CRACKING UNIT
7,950 m^3/day
(Concluded)

4. VESSELS

No.	Service	Diameter	Height	On a structure with an overall height of
		Dimensions (m)		
1	Reactor	9.7	14.3	23.4
1	Regenerator	18.1	10.7	30.5
1	Hot catalyst storage (2 vessels)	10.5	12.2	15.2

STANDARD UNIT NO. X27
PARA-XYLENE PLANT
140 Metric Tons/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Feed	x	C	C	M
1	1st stage melt		C	C	M
1	2nd stage melt		C	C	M
1	Splitter reflx	x	B	C	M
1	Make-up Toluene	x	C	C	M

2. VALVES AND FITTINGS

   a. Control Valves - 9

   b. Process Valves - 630

   c. Fittings - 2,115

   d. Relief Valves - 11

   e. Sample Connections - 16

STANDARD UNIT NO. X28
DELAYED COKER PLANT
7,950 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	Coker feed	x	D	C	P
3	Condensate	x	C	C	M
4	Gasoline	2x	B	C	M
3	Stripper bottoms	x	C	C	M
1	Reflux	x	C	C	M
1	Reflux	x	B	C	M
2	Compressor	x	A	C	P

2. VALVES AND FITTINGS

a. Control Valves - 27

b. Process Valves - 1,750

c. Fittings - 5,875

d. Relief Valves - 30

e. Sample Connections - 43

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
3	H	175	53.3	4*

* 2 Stacks

STANDARD UNIT NO. X29
SO_2 TREATING PLANT
1,100 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Feed	x	C	C	M
1	Raffinate	x	C	C	M
2	Caustic			C	R
2	Extract	x	C	C	M
1	Caustic scrubber		C	C	M
6	SO_2	3x	A	R	P
1	SO_2 reflux	x	A	R	P
1	Extractor feed		C	C	M
1	Acid		C	C	M
1	Raffinate				
4	SO_2 compressor	2x	A	R	P

2. VALVES AND FITTINGS

a. Control Valves - 43

b. Process Valves - 2,170

c. Fittings - 7,285

d. Relief Valves - 38

e. Sample Connections - 46

STANDARD UNIT NO. X30
ACID TREATING PLANT
447 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Kerosene feed	x	C	R	P
2	Kerosene Acid	x	C	R	P
1	Product	x	C	C	M
1	Brightener Feed		C	C	M
1	Caustic recycle	x	Aq	R	P
1	Salt Water Feed	x	Aq	C	P

2. VALVES AND FITTINGS

a. Control Valves - 12

b. Process Valves - 840

c. Fittings - 2,820

d. Relief Valves - 15

e. Sample Connections - 19

STANDARD UNIT NO. X31
GASOLINE SWEETENING UNIT
4,450 m^3/day

1. PUMPS AND COMPRESSORS

No.		Spare	RVP Class	Pump Type	Seal Type
1	Inhibitor transfer	x	D	R	P
1	Naphtha charge	x	B	C	M
1	Inhibitor solution		D	C	M
1	Inhibitor slurry recycle	x	D	C	M
1	Inhibitor injection		D	C	P

2. VALVES AND FITTINGS

   a. Control Valves - 6

   b. Process Valves - 560

   c. Fittings - 1,880

   d. Relief Valves - 8

   e. Sample Connections - 13

STANDARD UNIT NO. X32
CRUDE DISTILLATION UNIT
6,360 m^3/day

1. PUMPS ANC COMPRESSORS

No.		Spare	RVP Class	Pump Type	Seal Type
1	Primary feed	x	C	C	M
2	Secondary feed	x	C	C	M
2	Vacuum heater charge	x	D	C	M
2	Vacuum column bottoms	x	D	C	M
2	Atmos. column reflux	x	B	C	M
2	Vacuum column reflux	x	C	C	M
1	First sidecut		B	C	M
1	Second sidecut		C	C	M
1	Third sidecut		C	C	M
1	Fourth sidecut		C	C	M
1	Fifth sidecut		D	C	M
1	Sixth sidecut		D	C	M
1	Rectifier reflux	x	B	C	M
1	Rectifier feed	x	B	C	M
1	Seventh sidecut		D	C	M
1	Vacuum net overhead	x	D	C	M
1	Light oil feedback	x	C	R	P
1	Heavy oil feedback	x	C	R	P
1	Oil from vacuum skimmer		C	R	P
1	Rectifier net overhead	x	B	R	P

2. VALVES AND FITTINGS

a. Control Valves - 40

b. Process Valves - 2,590

c. Fittings - 8,695

d. Relief Valves - 45

e. Sample Connections - 56

STANDARD UNIT NO. X32
CRUDE DISTILLATION UNIT
6,360 m^3/day
(Concluded)

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	99	55	2.0
1	H	47	55	1.4

STANDARD UNIT NO. X33
CRUDE DESALTING UNIT
6,400 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	C	C	M

2. VALVES AND FITTINGS

a. Control Valves - 3

b. Process Valves - 140

c. Fittings - 470

d. Relief Valves - 2

e. Sample Connections - 5

STANDARD UNIT NO. X34
SPECIALTY CRUDE UNIT
1,530 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Primary feed		C	C	M
1	Secondary feed		C	C	M
2	Tar	x	D	R	P
1	Top stripper	x	B	C	M
1	Middle stripper		C	C	M
1	Bottom stripper		C	C	M
1	Intermediate reflux	x	B	R	P

2. VALVES AND FITTINGS

a. Control Valves - 11

b. Process Valves - 770

c. Fittings - 2,585

d. Relief Valves - 13

e. Sample Connections - 18

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	84	24.5	1.5

STANDARD UNIT NO. X35
GASOLINE FRACTIONATING UNIT
9,500 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
6	Reflux	3 x	B	C	M
6	Feed	3 x	B	C	M
6	Bottoms	3 x	B	C	M
6	1st sidecut	2 x	B	C	M
6	2nd sidecut	2 x	B	C	M
2	Compressors	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 54

b. Process Valves - 3,220

c. Fittings - 10,800

d. Relief Valves - 38

e. Sample Connections - 70

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	34.7	26.	1.5

STANDARD UNIT NO. X36
LOADING RACK FACILITY

A. TANK CAR LOADING RACK FACILITY

There are two long racks and one short rack with tracks on either side. The rack from which refined products are loaded is 3.8 m high x 680 m long x 10 m wide. A full spot, 18.3 m is alternated with a 1/2 spot, 9.1 m to facilitate car spotting. Groups of 6 to 8 risers are located at each spot, of which there are 25. Groups of 3 to 5 risers are located at the 1/2 spots, of which there are 24. Stocks over 10.3 kilo-pascals Reid vapor pressure are loaded with a vapor return to a recovery system. All other stocks are loaded with a submerged loading spout. All loading spouts are equipped with quick-closing type valves.

The rack from which the heavy fuels, furnace and stove oils and diesel fuels is 3.8 m high x 610 m long x 10 m wide. The same arrangement of spots and risers holds for these two tracks.

There are 22 spots and 23-1/2 spots.

The short rack is 3.8 m high x 183 m long x 10 m wide. This is a utility rack with 4 spots for car cleaning, 2 spots for off-test fuel and gasoline pumpout and 2 spots for xylene and purchased polymer pumpout.

B. TRUCK LOADING RACK FACILITY

This facility has three racks. The long one in the center is for gasolines and thinners over 10.3 kPa. All loading of this material is done with a vapor return system to the vapor recovery plant. It is able to load 3 trucks and trailers on each side. The rack is 55 m long. The loading platform is 3.8 m above ground level with a roof to an overall height of 7.62 m and is 7 m wide.

STANDARD UNIT NO. X36
(Continued)

The racks on either side can accommodate 2 trucks and trailers on each side. They are 36.6 m long, also with roofs to an over-all height of 7.62 m and are 7 m wide. One rack loads primarily heavy fuels and fuel oils. The other loads primarily jet fuels, kerosene type products and diesel oils.

c. VAPOR RECOVERY PACKAGE UNIT, ABSORPTION TYPE, 1000 Kg / hr.

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Vapor compressor	x	A	C	M
1	Gasoline Feed to absorber	x	B	C	M
1	Gasoline Feed to saturation pot	x	B	C	M
1	Gasoline to storage	x	B	C	M

2. VALVES AND FITTINGS

   a. Control Valves - 8
   b. Process Valves - 560
   c. Fittings - 1,880
   d. Relief Valves - 10
   e.Sample Connections - 8

3. VESSELS

   a. Vapor conservation tank, sphere type, 9 m diameter.

STANDARD UNIT NO. X37
VAPOR RECOVERY PLANT

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	Compressors	x	A	R	P
2	Condensate	x	B	R	P
1	Rich sponge oil	x	B	R	P
1	Lean sponge oil	x	C	R	P

2. VALVES AND FITTINGS

a. Control Valves - 12

b. Process Valves - 770

c. Fittings - 2,585

d. Relief Valves - 14

e. Sample Connections - 15

STANDARD UNIT NO. X38
SHIP AND BARGE LOADING FACILITY

A. WHARF

A wharf facility for barge and small tanker loading and unloading facilities is 20 meters wide x 275 meters long giving an area of 0.5 hectares. The capacity and input to this module is 8,000 m^3/day of products. The output is to off-plot customers.

There is little or no equipment inherent to this module other than the flexible hose connections between shore loading and displacement lines to those on the ship or barge along with handling equipment such as gantry cranes, etc.

Vapor recovery lines discharge to central gas recovery unit.

STANDARD UNIT NO. X39
GASOLINE RECTIFIER PLANT

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Compressor	x	A	R	P
2	Feed	x	B	R	P
1	Condensate	x	B	R	P
1	Bottoms	x	B	R	P
2	Reflux	x	B	R	P

2. VALVES AND FITTINGS

a. Control Valves - 14

b. Process Valves - 840

c. Fittings - 2,820

d. Relief Valves - 17

e. Sample Connections - 19

STANDARD UNIT NO. X40
WASTE WATER TREATMENT PLANT
20,000 m^3/day

The treatment process consists of an equalizing pond, two parallel air flotation units, an activated sludge tank, two parallel primary clarifiers, and a secondary clarifier. No chemical flocculating agents are used. Effluent from the secondary clarifier is discharged off-site. Sludge from the primary clarifiers is cycled back to the activated sludge tank. The organic content of sludge from the secondary clarifier is reduced in an incinerator. Ash from the incinerator is disposed off-site.

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Flotation cell feed	X	Aqueous	R	P

2. TREATMENT TANKS AND BASINS

		DIMENSIONS			
No.	Service	Diameter (m)	Height (m)	Width (m)	Length (m)
2	Air flotation cells	6.1	6.1		
1	Activated sludge cell		5.0	78.0	78.0
2	Primary clarifiers	24.4	3.7		
1	Secondary clarifier	12.2	6.1		
1	Equalizing pond		3.7	219.5	219.5

3. COMBUSTION DEVICES

a. Sludge Incinerator

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	Multiple Hearth	20.	12.2	1.0

STANDARD UNIT NO. X41
SOUR WATER OXIDIZER
250 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed	x	Aq	C	P
1	Product	x	Aq	C	P
1	Air Compressor				

2. VALVES AND FITTINGS

a. Control Valves - 3

b. Process Valves - 140

c. Fittings - 470

d. Relief Valves - 5

e. Sample Connections - 4

STANDARD UNIT NO. X42
SOLVENT DECARBONIZER
10,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Reduced crude feed	x	D	R	P
2	Asphalt	x	D	R	P
2	Propane	x	A	C	M
2	Compressors	x	A	C	M

2. VALVES AND FITTINGS

a. Control - 12

b. Process - 840

c. Fittings - 2,820

d. Relief Valves - 15

e. Sample Connections - 18

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	34.	21.	1.4
1	H	149.	30.*	1.7*
1	H	25.	21.	1.0

*Heater has two stacks, each stack 30.m high and 1.7m in diameter.

STANDARD UNIT NO. X43
THERMAL HYDRODEALKYLATION UNIT
260 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Toluene feed	x	C	C	M
1	Stabilizer reflux	x	C	C	M
1	Benzene reflux	x	C	C	M
1	Compressor	x	A	R	P

2. VALVES AND FITTINGS

a. Control Valves - 8

b. Process Valves - 560

c. Fittings - 1,880

d. Relief Valves - 9

e. Sample Connections - 10

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	21.0	36.6	1.1

STANDARD UNIT NO. X44
NAPHTHA HYDRODESULFURIZER
4,300 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Charge	x	B	C	M
1	Bottoms		C	C	M
2	Gasoline	x	B	C	M
1	Stabilizer feed	x	B	C	M
2	Compressors	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 15

b. Process Valves - 770

c. Fittings - 2,585

d. Relief Valves - 14

e. Sample Connections - 17

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	75.0	11.8*	1.1*

*Heater has three stacks, each stack 11.8m high and 1.1m in diameter.

STANDARD UNIT NO. X45
REFINERY STOCK TRANSFER CENTER

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
4	Product transfer	2X	B	R	P
4	Product transfer	2X	B	C	M
10	Product transfer	4X	C	R	P
6	Product transfer	3X	C	C	M
4	Product transfer	2X	D	R	P
2	Product transfer	X	D	C	M

2. VALVES AND FITTINGS

   a. Process Valves - 3,080

   b. Fittings - 10,340

Note: The estimated numbers include the valves at the pump manifolds, intermediate manifolds and those at the final stock destinations, such as tankage, within the refinery.

STANDARD UNIT NO. X46
ACID GAS TREATING PLANT (METHYLETHANOLAMINE ABSORPTION)

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Water	X	Aqueous	R	P
1	Lean MEA	X	Aqueous	R	P
1	Absorber Bottoms	X	Aqueous	R	P
1	Separator Pump	X	Aqueous	R	P

2. VALVES AND FITTINGS

a. Control Valves - 8

b. Process Valves - 560

c. Fittings - 1,880

d. Relief valves - 10

STANDARD UNIT NO. X47
BEAVON-STRETFORD SULFUR RECOVERY PLANT TAIL GAS CLEANUP UNIT
1.5×10^6 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Solution circ.	X	Aqueous	C	P
1	Sulfur slurry	X	Aqueous	C	P
1	Air blower		-	C	P

2. VALVES AND FITTINGS

a. Control Valves - 3

b. Process Valves - 280

c. Fittings - 940

d. Relief Valves - 4

e. Sample Connections - 6

3. VESSELS

a. Oxidizer 12 m diameter x 8 m high

b. Sulfur Slurry Tank 8 m diameter x 7 m high

c. Solution Tank 10 m diameter x 9 m high

STANDARD UNIT NO. X48
ALKYLATION UNIT
2,400 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Olefin feed	x	A	C	M
1	i-butane feed	x	A	C	M
1	Fractionator feed	x	A	C	M
1	Bottoms recirculation	x	A	C	M
1	Reflux	x	A	C	M
1	n-butane		A	R	P
1	Stab. Alkylate to storage	x	B	C	M
1	HF from rerun	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 15

b. Process Valves - 1,050

c. Fittings - 3,525

d. Relief Valves - 18

e. Sample Connections - 26

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	223.	41.8	2.9

STANDARD UNIT NO. X49
VACUUM UNIT
4,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Feed	x	D	C	M
1	Light Gas Oil	x	C	C	M
1	Heavy Gas Oil	x	D	C	M
2	Bottoms		D	C	M

2. VALVES AND FITTINGS

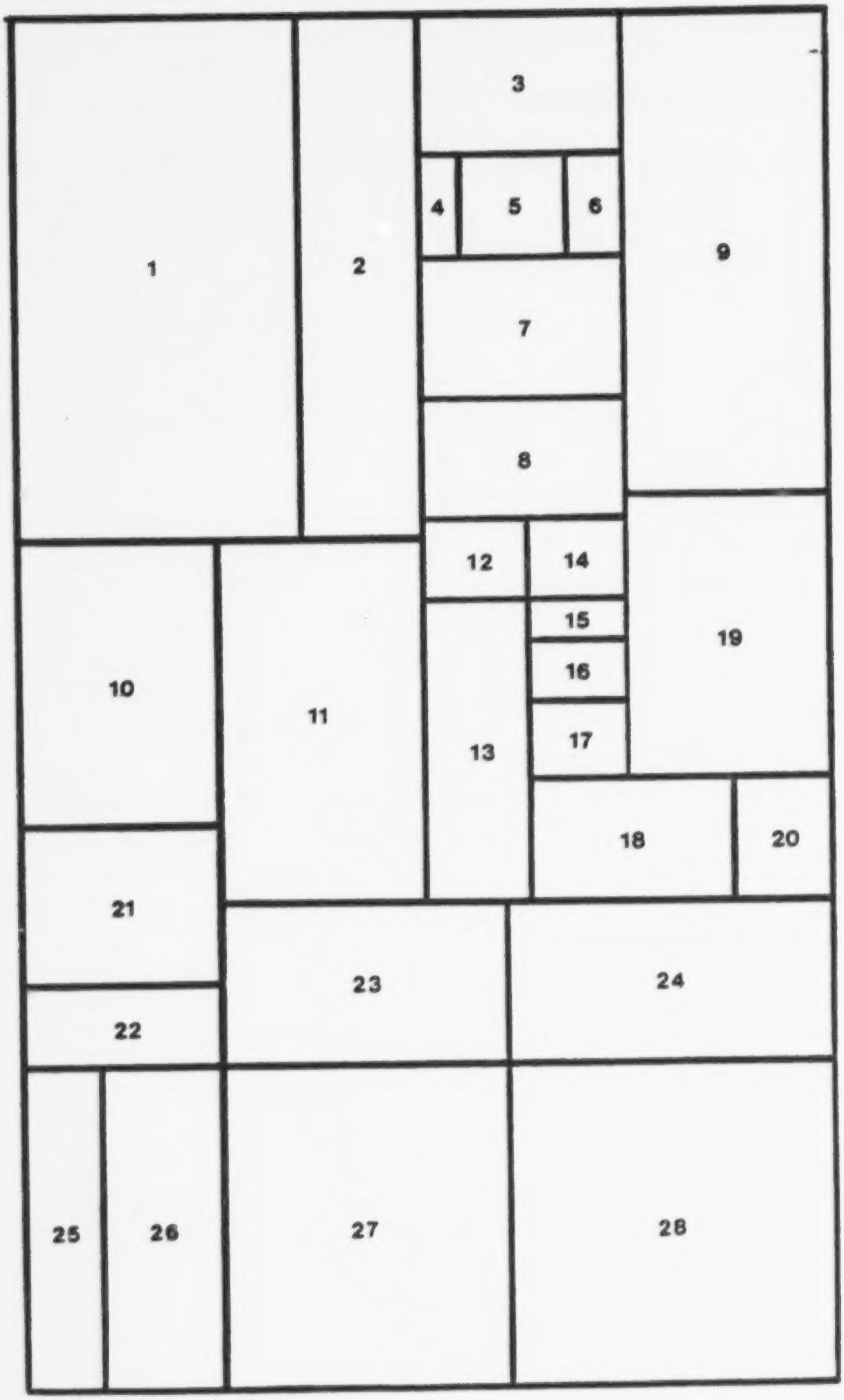
   a. Control Valves - 10
   b. Process Valves - 700
   c. Fittings - 2,350
   d. Relief Valves - 12
   e. Sample Connections - 14

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diamager (m)
1	H	106.	27.0	2.3

SMALL CAPACITY EXISTING REFINERY
Scale 1 inch = 120 meters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SMALL CAPACITY EXISTING REFINERY MODULE KEY

Module No.	Description	Standard Unit Reference No.
S1	Product Storage	-
S2	Product Storage	-
S3	Shops and Warehouse	-
S4	Cooling Towers	-
S5	Catalytic Reformer	X24
S6	Aromatics Extraction	X25
S7	Crude Distillation	X32, X34, X29
S8	Fluid Catalytic Cracking	X26
S9	Feedstock Storage	-
S10	Wastewater Treatment Plant	X40
S11	Feedstock Storage	-
S12	HF Alkylation/Gasoline Sweetening	X48, X31
S13	Product Storage	-
S14	Gas Concentration/Sulfur Recovery	X3, X20
S15	Gasoline Fractionation	X10
S16	Future Expansion	-
S17	Boiler House	-
S18	Product Storage	-
S19	Crude Oil Storage	-
S20	Administration Building and Laboratory	-
S21	Flares	-
S22	Truck Loading Rack Facility	X36
S23	Product Storage	-
S24	Feedstock Storage	-
S25	Rail Loading Rack Facility	-
S26	Crude Oil Storage	-
S27	Product Storage	-
S28	Product Storage	-

SMALL CAPACITY EXISTING REFINERY

CRUDE CHARGE RATE 8,000 m^3/day

PRODUCT SLATE

PRODUCT	PRODUCTION RATE (m^3/day)
Gasoline	4,200
Bunker C	1,100
Diesel	1,050
#2 Fuel oil	625
Light Catalytic Cracker Cycle Oil	500
Kerosene	265
Toluene	155
Xylene	100
Benzene	90
Alkylate	75
Heavy Aromatics	40
	8,200

NUMBER OF WHARF MODULES 1

MODULE NO. S1
PRODUCT STORAGE

Module area = 8.2 hectares: 390m x 210m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Kerosene	0.21	XR	12.9	12.2	1,590	68,900
2	Kerosene	0.21	XR	39.9	12.2	15,263	206,000
2	Kerosene	0.21	XR	41.8	12.2	16,716	213,050
1	Kerosene	0.21	XR	36.0	12.2	12,401	178,000
1	#2 fuel oil	0.14	XR	39.9	12.2	15,263	116,000
1	#2 fuel oil	0.14	XR	29.7	12.2	8,430	213,600
2	Bunker "C"	0.0007	XR	36.4	12.2	12,719	189,000

MODULE NO. S2
PRODUCT STORAGE

Module area = 3.5 hectares: 390m x 90m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Xylene	3.4	XR	36.2	12.2	12,560	26,700
1	Toluene	7.6	XR	36.2	12.2	12,560	49,600
1	Cumene	1.4	XR	36.0	12.2	12,400	156,000

MODULE NO. S3
SHOPS AND WAREHOUSE

Module area = 1.6 hectares: 150m x 105m

	DIMENSIONS		
	Width (m)	Length (m)	Height (m)
A. Building	12.	46.	15.
B. Building	19.	38.	9.
C. Building	8.	19.	6.

MODULE NO. S4
COOLING TOWERS

Module area = 0.2 hectares: 75m x 30m

	DIMENSIONS			Water Flow Rate Capacity (m^3/hr)
	Width (m)	Length (m)	Height (m)	
A. Cooling tower	15.6	91.8	8.	20,550
B. Cooling tower	14.6	81.6	8.	14,000

MODULE NO. S5
CATALYTIC REFORMER

Module area = 0.6 hectares: 75m x 75m

Process Input/Output:

The input to the module is naphtha from the first distillation. The output is gas and condensate to the gas concentration unit and product to aromatics extraction unit or to gasoline blending.

A. CATALYTIC REFORMER 7,200 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X24

2. VALVES AND FITTINGS

   See Standard Unit No. X24

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
2	H	37.	17.4	1.2
2	H	53.	17.4	1.2

MODULE NO. S6
AROMATICS EXTRACTION

Module area = 0.3 hectares: 75m x 45m

Process Input/Output:

The input to this module is reformate from the catalytic reformer. The output is benzene, toluene, xylene, heavy aromatics and raffinate to gasoline blending.

A. AROMATICS EXTRACTION 600 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X25

2. VALVES AND FITTINGS

   See Standard Unit No. X25

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
2	H	58.	16.8	1.5
1	H	84.	30.1	1.6

MODULE NO. S7
CRUDE DISTILLATION

Module area = 1.6 hectares: 150m x 105m

Process Input/Output:

> The input to the module is mixed crudes. The output is gas to the gas concentration unit; gasoline to blending; naphtha to catalytic reformer; kerosene and fuel oil to product storage; gas oil to catalytic cracking and reduced crude to vacuum unit.

A. CRUDE DESALTING UNIT 10,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Feed	x	C	C	M

2. VALVES AND FITTINGS
   a. Control Valves - 3
   b. Process Valves - 210
   c. Fittings - 705
   d. Relief Valves - 4
   e. Sample Connections - 5

B. CRUDE DISTILLATION UNIT 6,360 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X32

2. VALVES AND FITTINGS

   See Standard Unit No. X32

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	216.	38.1	2.4
1	H	63.	31.3	1.8

C. CRUDE DISTILLATION UNIT 1,530 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X34

2. VALVES AND FITTINGS

   See Standard Unit No. X34

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	52.	27.4	1.6

D. VACUUM UNIT 4,000 m^3/day

See Standard Unit No. X49

MODULE NO. S8
FLUID CATALYTIC CRACKING

Module area = 1.4 hectares: 150m x 90m

Process Input/Output:

The input to this module is the gas oils from the crude distillation. The output is gas and unstabilized gasoline to the gas concentration unit, light cycle oils to No. 2 fuel and clarified slurry to Bunker "C" fuel.

A. FLUID CATALYTIC CRACKING UNIT 4,800 m^3/day

See Standard Unit No. X26

MODULE NO. S9
FEEDSTOCK STORAGE

Module area = 5.4 hectares: 360m x 150m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
3	FCC Feed	0.14	XR	36.2	12.2	12,600	590,530
1	FCC Feed	0.14	XR	39.9	12.2	15,260	18,170
1	Vacuum Feed	0.14	XR	18.2	12.2	3,180	1,419,450

MODULE NO. S10
WASTEWATER TREATMENT PLANT

Module area = 3.2 hectares: 210m x 150m

Process Input/Output:

The input is the skimmed oily water effluent from the separators. The output is clarified water for disposal in oceans, rivers, ponds, or by irrigation. Sludge is disposed by incineration or landfill.

A. WASTEWATER TREATMENT PLANT 20,000 m^3/day

See Standard Unit No. X40

MODULE NO. S11
FEEDSTOCK STORAGE

Module area = 4.1 hectares: 270m x 150m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Propane	1,303	P*	6.7		160	78,200
2	Propylene	1,585	P*	5.3		80	47,700
2	n-Butane	352	P*	14.0		1,430	130,000
2	ISO-Butane	503	P*	17.9		3,020	54,500
2	Alkylation feed	155	P*	17.9		3,020	436,000

* Pressure sphere

MODULE NO. S 12
HF ALKYLATION/GASOLINE SWEETENING

Module area = 0.5 hectares: 75m x 60m

Process Input/Output:

The input to this module is butanes, butylene, propane, propylene, and gasoline from the gas concentration unit. Additional gasoline is received from the crude distillation unit. The output is propane and n-butane to pressure storage and alkylate and gasoline to gasoline blending.

A. HF ALKYLATION UNIT 1,600 m^3/day

See Standard Unit No. 48

B. GASOLINE SWEETENING UNIT 4,300 m^3/day

See Standard Unit No. 48

MODULE NO. S13
PRODUCT STORAGE

Module area = 1.7 hectares: 225m x 75m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Hvy aromatics	3.4	XR	8.2	9.1	477.	6,800
2	Cumene	1.4	XR	8.2	9.1	477.	40,800
2	Xylene	3.4	XR	10.4	9.1	795.	13,355
1	Hvy aromatics	3.4	XR	18.2	12.2	3,180.	7,650
1	Slop oil	3.4	XR	8.1	6.1	312.	3,700
2	Slop oil	3.4	XR	3.7	6.1	64.	3,400
1	Slop oil	3.4	XR	5.8	6.1	160.	2,135

MODULE NO. S14
GAS CONCENTRATION/SULFUR RECOVERY

Module area = 0.5 hectares: 75m x 60m

Process Input/Output:

The input to this module is the gases and gasoline from the fluid catalytic cracking unit and the gases and light ends from other units such as the crude distillation units. The output is acid gas for sulfur recovery, gas to refinery fuel, gasoline to blending, propane/propylene to cumene or alkylation feed and butane/butylene to alkylation feed.

A. GAS CONCENTRATION UNIT 85,000 m^3/day

See Standard Unit No. X50

B. ACID GAS TREATING PLANT

See Standard Unit No. X46

C. SULFUR RECOVERY UNIT 272 metric tons/day

See Standard Unit No. X20

D. TAIL GAS CLEAN-UP UNIT

See Standard Unit No. X21 and X22

MODULE NO. S-15
GASOLINE FRACTIONATION

Module area = 0.2 hectares: 75m x 30m

Process Input/Output:

The input to this module is naphtha from the first crude distillation units. The output is feed stock to the catalytic reformer, gas concentration unit and gasoline blending.

A. GASOLINE FRACTIONATING UNIT 2,000 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Reflux	x	B	C	M
2	Feed	x	B	C	M
2	Bottoms	x	B	C	M
2	1st Side Cut	x	B	C	M
2	2nd Side Cut	x	B	C	M
2	Compressors	x	A	C	M

2. VALVES AND FITTINGS

a. Control Valves - 20

b. Process Valves - 1,260

c. Fittings - 4,230

d. Relief Valves - 22

e. Sample Connections - 31

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	15.6	26	0.8

MODULE NO. S16
FUTURE EXPANSION

Module area = 0.3 hectares: 75m x 45m

This area is reserved for future expansion.

MODULE NO. S-17
BOILER HOUSE

Module area = 0.5 hectares: 75m x 60m

A. BOILER HOUSE

1. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
2	B	400.	30.*	2.5

*Boilers share common stack

2. BUILDING

15m wide X 36m long X 9m high

MODULE NO. S18
PRODUCT STORAGE

Module area = 1.4 hectares: 150m x 90m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Benzene	23	FR	10.5	9.1	795	11,360
1	Benzene	24	FR	15.2	12.2	2,230	51,500
1	Benzene	23	FR	24.4	12.2	3,730	55,350
2	Toluene	7.6	XR	10.5	9.1	795	29,530

MODULE NO. S19
CRUDE OIL STORAGE

Module area = 3.2 hectares: 210m x 150m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Crude	9.3	FR	36.7	14.6	15,400	681,380
2	Crude	10.3	FR	59.9	14.6	41,150	522,400
1	Crude	9.6	XR	39.7	12.2	15,100	125,900

MODULE NO. S20
ADMINISTRATION BUILDING AND LABORATORY

Module area = 0.7 hectares: 90m x 75m

	DIMENSIONS		
	Width (m)	Length (m)	Height (m)
A. Administration building	12.	20.	9.
B. Laboratory	15.	40.	9.

MODULE S21
FLARES

Module area = 1.8 hectares: 150m x 120m

A. FLARES

No.	Type	Capacity (m^3/hr)	Height (m)
1	Smokeless with automatic steam control	56,600	35
1	Smokeless with automatic steam control	40,000	31

MODULE NO. S 22
TRUCK LOADING RACK FACILITY

Module area = 0.9 hectares: 150m x 60m

Process Input/Output:

The input to this module is 100,000 m^3/year of various products to be transported by truck and trailer. Control strategy includes a vapor recovery system for products with vapor pressurs of 10 kPa or higher.

A. TRUCK LOADING RACK FACILITY

See Standard Unit no. X36

b. VAPOR RECOVERY PACKAGE UNIT, ABSORPTION TYPE 1,000 kg/hr

See Standard Unit no. X36

MODULE NO. S 23
PRODUCT STORAGE

Module area = 2.5 hectares: 210m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Natural gasoline	83	FR	17.9	14.6	3,657	36,250
1	Raffinate gas.	24	FR	32.5	14.6	12,100	269,000
1	FCC gasoline	63	FR	60.3	14.6	41,650	1,024,520
1	FCC gasoline	63	FR	32.9	14.6	12,400	70,500

MODULE NO. S 24
FEEDSTOCK STORAGE

Module area = 2.9 hectares: 240m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Platformer feed	21	FR	32.9	14.6	12,400	227,130
2	Heavy naptha	39	FR	33.3	14.6	12,800	204,400
1	Alkylate	34	FR	36.1	14.6	14.950	366,130

MODULE NO. S25
RAIL LOADING RACK FACILITY

Module area = 1.4 hectares: 240m x 60m

Process Input/Output:

The input to this module is toluene and xylene, the only products to be loaded into rail tank cars. The yearly combined throughput is 8,000 m^3. Control strategy consists only of submerged fill techniques.

A. TANK CAR LOADING RACK FACILITY

8-spot rack, 10 m wide x 180 m/long x 4 m high

MODULE NO. S 26
CRUDE OIL STORAGE

Module area = 2.2 hectares: 240m x 90m
Average module height = ground level except as indicated below

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Crude	8.9	FR	36.7	14.6	15,420	795,760
2	Crude	8.9	XR	35.8	12.2	12,240	591,500

MODULE NO. S 27
PRODUCT STORAGE

Module area = 5.0 hectares: 240m x 210m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	#2 fuel oil	0.14	XR	18.2	12.2	3,180	261,400
2	#2 fuel oil	0.14	XR	36.2	12.2	12,560	181,700
1	#2 fuel oil	0.14	XR	39.9	12.2	15,260	225,700
1	#2 fuel oil	0.14	XR	10.6	9.1	795	30,500

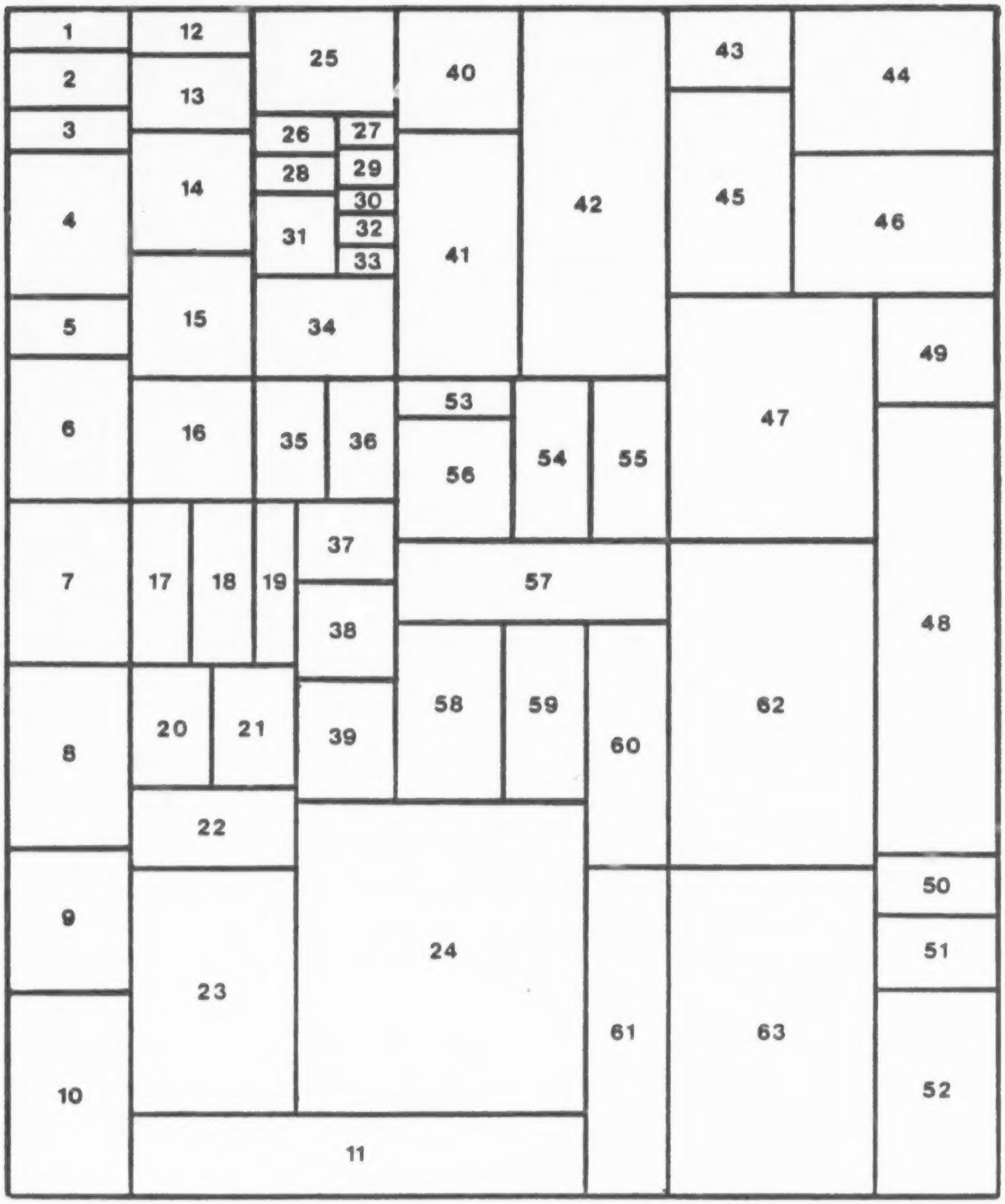
MODULE NO. S28
PRODUCT STORAGE

Module area = 5.8 hectares: 240m x 240m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Motor gasoline	69	FR	32.9	14.6	12,400	343,400
3	Motor gasoline	69	FR	36.7	14.6	15,420	440,700
1	Motor gasoline	69	FR	40.1	14.6	19,050	450,250
1	Motor gasoline	69	FR	45.0	14.6	23,200	181,700
1	Motor gasoline	69	FR	32.5	14.6	12,100	227,100

INTERMEDIATE CAPACITY EXISTING REFINERY
Scale 1 inch = 240 meters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INTERMEDIATE CAPACITY EXISTING REFINERY MODULE KEY

Module No.	Description	Standard Unit Reference No.
M1	Sourwater Oxidizer	X41
M2	Crude Distillation/Crude Desalting	X12
M3	Crude Distillation	X32
M4	Wastewater Treatment	X40
M5	Store House	-
M6	Boiler Feedwater Treating	-
M7	Boiler House	-
M8	Treating Plant	-
M9	Product Transfer/Wastewater Facilities	-
M10	Drum Filling	-
M11	Tank Car and Truck Loading	-
M12	Flares	-
M13	Solvent Decarbonizer	X42
M14	Product Handling	-
M15	Store House	-
M16	Product Storage	-
M17	Aromatics Extraction	X25
M18	Thermal Hydrodealkylation	X43
M19	Future Expansion	-
M20	Naptha Desulfurizer	X44
M21	Naphtha Desulfurizer	X44
M22	Product Storage	-
M23	Product Storage	-
M24	Product Storage	-
M25	Water Handling Facilities	-
M26	Catalytic Cracker	X26
M27	Acid-Gas Treating	X46
M28	Sulfur Recovery	X20, X47
M29	Gasoline Sweetening	X31
M30	Fractionating Unit	-
M31	Catalytic Cracking	X26
M32	Fractionating Unit	-
M33	Hydrogen Manufacture	X7
M34	Alkylation	X48
M35	Naphtha Hydrotreater	X2
M36	Naphtha Hydrotreater	X2
M37	Catalytic Reformer	X24
M38	Catalytic Reformer	X24
M39	Steam Generating Plant	-
M40	Flares	-
M41	Product Storage/Truck Loading	-
M42	Product Storage	-

INTERMEDIATE CAPACITY EXISTING REFINERY MODULE KEY

Module No.	Description	Standard Unit Reference No.
M43	Oil-Water Separator	-
M44	Product Storage	-
M45	Product Storage	-
M46	Product Storage	-
M47	Product Storage	-
M48	Product Storage	-
M49	Material Storage	-
M50	Product Shipment	X36
M51	Flare	-
M52	LPG Tank Loading	-
M53	Future Expansion	-
M54	Product Storage	-
M55	Buildings	-
M56	Product Storage	-
M57	Product Storage	-
M58	Administration Building	-
M59	Building	-
M60	Product Storage/Shipping	-
M61	Truck Loading	-
M62	Product Storage	-
M63	Product Storage	-

The wastewater separator in Module M12 treats the aqueous discharge of Modules M1, M2, M3, M12, M13, and M14.

The wastewater separator located in Module M25 treats the aqueous discharge of Modules M4-M6, M15-M21, M25-M38, and M40 and M41.

The separator in Module M43 treats discharge from Modules M43-M52 and M62-M63.

The separator in Module M9 treats the discharge from the remaining modules.

INTERMEDIATE CAPACITY EXISTING REFINERY

CRUDE CHARGE RATE — 32,000 m^3/day

PRODUCT SLATE

PRODUCT	PRODUCTION RATE (m^3/day)
Gasoline	19,000
Distillate fuel oil	8,000
Asphalt	3,200
Residual fuel oils	2,300
Jet fuel	1,000
Lube oils	900
Mixed olefins	750
Kerosene	600
Benzene	350
Naptha	240
Xylene	60
	36,400

NUMBER OF WHARF MODULES — 3

MODULE NO. M1
SOUR WATER OXIDIZER

Module area = 1.1 hectares: 180m x 60m

Process Input/Output:

Sour water containing hydrogen sulfide and ammonia is contacted with air at about 93°C to oxidize the hydrogen sulfide primarily to thiosulfate. Residual air with stripped ammonia is sent to a furnace.

A. SOUR WATER OXIDIZER, 950 m^3/day
See Standard Unit X41

MODULE NO. M2
CRUDE DISTILLATION UNIT

Module area = 1.5 hectares: 180m x 84m

Process Input/Output:

Besides a desalting crude oil feed, there is a crude oil distillation unit with an associated vacuum unit. Four fractions from the atmospheric column are charged to four strippers stacked in one column. Products include light ends, gasoline, naphtha, furnace oil and light gas oil. The bottoms are further distilled in a vacuum unit to provide heavier gas oils and a bottom product for further processing.

A. CRUDE DESALTING UNIT 31,800 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
2	Feed	X	C	C	M

2. VALVES AND FITTINGS
   - a. Control valves - 3
   - b. Process valves - 100
   - c. Fittings - 500
   - d. Relief valves - 3
   - e. Sample Connections - 3

3. STEAM HEATER

B. CRUDE DISTILLATION UNIT 23,850 m^3/day

1. PUMPS AND COMPRESSORS

See Standard Unit No. X12

2. VALVES AND FITTINGS

See Standard Unit No. X12

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	395	61.0	4.1*
1	H	151	61.0	4.1*

*common stack

C. COOLING TOWER

19.8 m wide x 57.9 m long x 9.1 m high

12,700 m^3/hr water flow rate

D. COOLING TOWER

12.2 m wide x 18.3 m long x 7.6 m high

2,900 m^3/hr water flow rate

MODULE NO. M3
CRUDE DISTILLATION UNIT

Module area = 1.2 hectares: 180m x 66m

Process Input/Output:

The feed and products are the same as those in Module No. M2

A. CRUDE DISTILLATION UNIT 8,000 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X32

2. VALVES AND FITTINGS

   See Standard Unit No. X32

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	125	55	2.2
1	H	59	55	1.6

MODULE NO. M4
WASTE WATER TREATMENT PLANT

Module area = 3.8 hectares: 210m x 180m

Process Input/Output:

The input is skimmed oily water effluent from the separators. The output is clarified water for disposal in oceans, rivers, ponds or by irrigation. Sludge is disposed by incineration or landfill.

A. WASTE WATER TREATMENT PLANT 20,000 m^3/day

See Standard Unit No. X40

B. SLUDGE INCINERATOR

7.6 m wide x 7.6 m long x 9.2 m high overall

B. SLUDGE INCINERATOR (Concluded)

Capacity - 9,100 kg/hr

Equipped with a Venturi scrubber

C. OIL-WATER SEPARATOR

9.2 m wide x 42.7 m long

It is equipped with a floating roof

D. SETTLING BASIN

18.3 m wide x 30.5 m long extending 1.0 m above ground level

E. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Waste water	Aqueous	XR	42.7	13.7	19,600	254,800
2	Waste water	Aqueous	XR	38.1	12.2	13,900	180,700
2	Slop oil	0.5	XR	18.3	4.6	1,200	15,600
4	Caustic soda	Aqueous	XR	11.4	4.6	450	5,850
4	Sulfuric acid	Chemical	XR	11.4	4.6	450	5,850

MODULE NO. M5
STORE HOUSE

Module area = 1.6 hectares: 180m x 90m

This area is essentially a storehouse area for receiving and dispatching equipment, materials, valves, etc.

A. STOREHOUSE

61.0 m wide x 91.4 m long x 12.2 m high

MODULE NO. M6
BOILER FEED WATER TREATING PLANT

Module area = 3.8 hectares: 210m x 180m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
5	Water	Aqueous	XR	15.2	9.1	1,650	21,450
2	Chlorine	-	P	1.2	4.9	900 kg	

B. COAGULATION BASIN

54.9 m wide x 61.0 m long

Associated flocculator, precipitator filters and softeners

MODULE NO. M7
BOILER HOUSE

Module area = 4.3 hectares: 240m x 180m

The output is plant steam

A. BOILER HOUSE

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
5	Water	X	Aqueous	C	M
4	Fuel oil	X	D	C	M

2. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
3	B	475 each	61.0	5.8*
1	B	633	61.0	5.8*

*Common stack

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Water	Aqueous	Open	15.2	9.1	1,650	21,450
9	#2 Fuel oil	0.1	XR	12.2	7.6	890	11,570
2	#6 Fuel oil	0.1	XR	6.1	4.6	130	1,690
3	#6 Fuel oil	0.1	XR	4.6	3.7	60	780

	DIMENSIONS		
	Width	Length	Height
C. BUILDING	61.0	76.2	15.2
D. BUILDING	30.5	114.3	10.7

MODULE NO. M8
TREATING PLANT

Module area = 4.9 hectares: 270m x 180m

Process Input/Output:

Inputs are solvents, thinners, and kerosene from feedstock storage. Outputs, stocks treated to improve their color, go to product storage.

A. TREATING PLANT

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
4	Solvents	X	D	C	M
2	Thinners	X	D	C	M
1	Kerosene	X	D	C	M
3	Water		Aqueous	R	P
1	Sulfuric acid	X	-	R	P
1	Caustic soda	X	Aqueous	R	P

2. VALVES AND FITTINGS
    - a. Control Valves - none
    - b. Process Valves - 700
    - c. Fittings - 2,350
    - d. Relief Valves - 4
    - e. Sample Connections - 12

B. SEPARATOR BOX

15.2m wide x 41.1m long
API type with floating roof

C. SEPARATOR BOX

7.6m wide x 41.1m long
API type with floating roof

MODULE NO. M9
PRODUCT TRANSFER/WASTE WATER FACILITIES

Module area = 3.8 hectares: 210m x 180m

A. PUMP HOUSE

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	Product transfer	X	B	C	M
5	Product transfer	X	C	C	M
3	Product transfer	X	D	R	P

2. VALVES AND FITTINGS

a. Control Valves - none
b. Process Valves - 490
c. Fittings - 1,645
d. Relief Valves - 14
e. Sample Connections - 14

B. COMBUSTION DEVICES

a. Sludge incinerator

No.	Type	Design Capacity (Kg/hr)	Stack Height (m)	Stack Diameter (m)
1	multiple hearth	910	12.2	1.0

C. OIL WATER SEPARATOR API type

22.9m wide x 42.7m long x 3m high
API type with a floating roof
Capacity 22,800 m^3/day

D. OIL-WATER SEPARATOR

4.6 m wide x 12.2 m long x 3 m high

CPI type with a fixed roof

Capacity 3,000 m^3/day

E. MULTIPLE SETTLING BASIN

12.2 m wide x 30.5 m long x 2.6 m deep, 750 m^3 capacity

F. MUD SETTLING POND

30.5 m wide x 51.8 m long x 1.8 m deep

Capacity 2,850 m^3

G. BUILDING

18.3 m wide x 39.6 m long x 7.6 m high

MODULE NO. M10
DRUM FILLING PLANT

Module area = 5.4 hectares: 300m x 180m

A. DRUM FILLING PLANT

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Off-test product	X	D	C	M
3	Solvents	X	D	C	M
3	Thinners	X	D	C	M

2. VALVES AND FITTINGS

   a. Control Valves - none

   b. Process Valves - 230

   c. Fittings - 780

   d. Relief Valves - 10

   e. Sample Connections - 10

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Off-test thinners	1.0	XR	4.3	4.6	65	845
2	Thinners	0.7	XR	12.2	9.1	1,050	13,650
8	Solvents	0.7	XR	7.0	6.1	235	3,050
9	Thinners	1.4	XR	2.4	4.6	20	260
1	Off-test solvents	1.0	XR	9.1	5.5	360	4,680

	DIMENSIONS		
	Width	Length	Height
C. BUILDING	21.3	41.1	9.1
D. BUILDING	30.5	54.9	13.7
E. BUILDING	18.3	30.5	9.1

MODULE NO. M11
TANK CAR AND TRUCK LOADING RACKS

Module area = 7.9 hectares: 660m x 120m

A. PUMP HOUSE

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	Diesel	X	D	C	M
4	Commercial jet fuel	X	D	C	M
1	Xylene		D	C	M
1	Benzene		C	C	M
2	Fuel oil	X	D	R	P
6	Solvents	3X	D	C	M
3	Lube oils	X	D	R	P

2. VALVES AND FITTINGS
   a. Control Valves - none
   b. Process Valves - 650

2. VALVES AND FITTINGS (Concluded)
    c. Fittings - 2,030
    d. Relief Valves - 27
    e. Sample Connections - 27

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Diesel fuel	0.1	XR	7.3	6.1	250	3,250
9	Comm'l jet fuel	1.4	XR	9.4	7.6	530	6,890
9	Toluene	7.6	XR	7.0	7.6	290	3,770
5	Diesel fuel	0.1	XR	14.6	6.1	1,020	13,260
1	Benzene	23.	FR	14.6	6.1	1,020	13,260
6	Fuel oil	0.1	XR	15.2	7.6	1,380	17,940
2	Solvent	0.7	XR	6.7	6.1	210	2,730
3	Comm'l jet fuel	1.4	XR	7.9	7.6	370	4,810
5	Lube oil	below 0.1	XR	4.3	6.1	90	1,170
55	Solvent and components	0.7	XR	3.7	6.1	60	780
3	Lube oil	below 0.1	XR	4.9	6.1	110	1,430

C. TANK CAR LOADING RACK

6.1 m wide x 33.5 m long x 5.5 m high

D. SOLVENT AND LUBE OIL TRUCK LOADING RACK

6.1 m wide x 10.7 m long x 4.6 m high

E. BUILDING

12.2 m wide x 33.5 m long x 9.1 m high

MODULE NO. M12
FLARES

Module area = 1.2 hectares: 180m x 66m

A. FLARE

Smokeless type with automatic steam control, TV-monitored

36.6 m high

Capacity 78,000 m^3/hr

B. FLARE

Smokeless type with automatic steam control, TV-monitored

30.5 m high

Capacity 50,000 m^3/hr

C. OIL-WATER SEPARATOR

19.8 m wide x 38.1 m long x 3.0 m high

API type with a floating roof

MODULE NO. M13
SOLVENT DECARBONIZER

Module area = 2.1 hectares: 180m x 114m

Process Input/Output:

Feeds to this unit are reduced crude and propane. Products are decarbonized oil which can be catalytically cracked and asphalt which can be blended to make fuel oil. Propane is recycled.

A. SOLVENT DECARBONIZER 8,000 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X42

2. VALVES AND FITTINGS

   See Standard Unit No. X42

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	27	21	1.3
1	H	119	(two) 30	1.5
1	H	20	21	0.9

MODULE NO. M14
PRODUCT HANDLING

Module area = 3.2 hectares: 180m x 180m

A. PUMPHOUSE

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Propane/propylene	X	A	C	M
1	Cumene		D	C	M
1	Toluene		D	C	M
1	Benzene	X	C	C	M
1	Solvent	X	D	C	M
1	Commercial jet fuel	X	D	C	M
1	Fuel oil		D	R	P

2. VALVES AND FITTINGS

a. Control Valves - none

b. Process Valves - 330

c. Fittings - 1,140

d. Relief Valves - 11

e. Sample Connections - 11

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
24	Solvent	0.7	XR	5.8	6.1	160	2,080
4	Toluene	7.6	XR	13.7	10.7	1,300	16,900

B. TANKS (Concluded)

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
3	Cumene	1.4	XR	12.2	9.1	1,050	13,650
2	Commercial jet fuel	1.4	XR	9.1	7.6	500	6,500
7	Fuel oil	0.14	XR	7.3	6.1	250	3,250
3	Benzene	23.	FR	7.3	7.6	320	4,160
2	Propane/ propylene	1,600	P	3.0	6.1	45	585

C. BUILDING

7.6 m wide x 61.0 m long x 4.6 m high

MODULE NO. M15
STOREHOUSE

Module area = 3.2 hectares: 180m x 180m

A. STOREHOUSE

45.7 m wide x 91. 4 m long x 9.1 m high

MODULE NO. M16
PRODUCT STORAGE

Module area = 3.2 hectares: 180m x 180m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
3	Catalytic cracking feed	0.1	XR	18.3	6.1	1,600	20,800
3	Alkylate	34.	FR	27.4	7.6	4,480	58,240

MODULE NO. M17
AROMATICS EXTRACTION PLANT

Module area = 2.2 hectares: 240m x 90m

Process Input/Output:

Inputs to this unit are reformates. Benzene, toluene and xylenes (up to a total of 600 m^3) can be produced depending upon the boiling range of the feed. The toluene can be charged to a thermal hydrodealkylation unit for manufacture of additional benzene (Module No. M18). Benzene can be charged to a cumene unit (Module No. M19).

A. AROMATIC EXTRACTION PLANT 600 m^3/day

See Standard Unit No. X25

MODULE NO. M18
THERMAL HYDRODEALKYLATION UNIT

Module area = 2.2 hectares: 240m x 90m

Process Input/Output:

Toluene is converted in the presence of hydrogen to benzene with some light gas as a by-product.

A. THERMAL HYDRODEALKYLATION 260 m^3/day

See Standard Unit No. X43

MODULE NO. M19
FUTURE EXPANSION

Module area = 1.4 hectares: 240m x 60m

This area is reserved for future expansion.

MODULE NO. M20
NAPHTHA DESULFURIZER

Module area = 2.2 hectares: 180m x 120m

Process Input/Output:

Gas oil feed is desulfurized in the presence of hydrogen to produce feed for a catalytic cracking unit and #2 fuel oil. Sulfur compounds are converted to hydrogen sulfide with the production of some light gases.

A. NAPHTHA DESULFURIZER 4,300 m^3/day

See Standard Unit No. X44

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
10	Hydrotreated gas oil	10.	XR	12.2	7.6	890	11,570
3	Diesel fuel	0.1	XR	6.1	4.6	135	1,755
1	Gas oil	10.	XR	18.3	9.1	2,400	31,200

MODULE NO. M21
NAPHTHA DESULFURIZER

Module area = 2.2 hectares: 180m x 120m

Process Input/Output:

Gas oil is desulfurized in the presence of hydrogen to produce feed for a catalytic cracking unit. Sulfur compounds are converted to hydrogen sulfide with the production of some light gases.

A. NAPHTHA DESULFURIZER 5,250 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X44

2. VALVES AND FITTINGS

   See Standard Unit No. X44

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	92	11.8	1.2 - three stacks

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
10	Hydrotreated gas oil	10	XR	12.2	7.6	890	11,570
3	Diesel fuel	0.1	XR	6.1	4.6	135	1,755
1	Gas oil	10	XR	18.3	9.1	2,400	31,200

MODULE NO. M22
PRODUCT STORAGE

Module area = 2.9 hectares: 240m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Fuel oil	0.14	XR	9.1	5.5	360	4,680
4	Straight run gasoline	74.	FR	24.4	10.7	5,000	65,000

MODULE NO. M23
PRODUCT STORAGE

Module area = 10.8 hectares: 360m x 300m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
7	Commercial jet fuel	1.4	XR	35.1	9.1	8,800	114,400
3	Heavy gas oil	0.1	XR	14.6	6.1	1,000	13,000

MODULE NO. M24
PRODUCT STORAGE

Module area = 19.2 hectares: 456m x 420m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Gasoline	80	XR	35.1	9.1	8,800	114,400
1	Gasoline	80	XR	28.0	9.8	6,000	78,000
4	Fuel oil	0.1	XR	35.1	9.1	8,800	114,400
4	Reformer feed	39	FR	28.0	9.8	6,000	78,000
1	Cutter stock	0.1	XR	24.4	8.0	3,700	48,100
1	Commercial jet fuel	1.4	XR	20.7	8.2	2,750	35,750
4	Solvents	0.7	XR	12.2	5.5	550	8,450

MODULE NO. M25
WATER HANDLING FACILITIES

Module area = 3.1 hectares: 204m x 150m

A pump house, cooling towers, mud settling ponds, primary separators and a secondary separator are located in the module.

A. PUMPHOUSE

13.7 m wide x 61.0 m long x 10.7 m high

B. COOLING TOWER

15.2 m wide x 91.4 m long x 9.1 m high

17,700 m^3/hr water flow rate

C. COOLING TOWER

15.2 m wide x 68.6 m long x 9.1 m high

12,200 m^3/hr water flow rate

D. MUD SETTLING POND

22.9 m wide x 68.6 m long x 3.0 m deep

E. MUD SETTLING POND

22.9 m wide x 38.1 m long x 3.0 m deep

F. PRIMARY OIL-WATER SEPARATORS

19.8 m wide x 38.1 m long

Floating roof type

G. SECONDARY OIL-WATER SEPARATOR

38.1 m wide x 61.0 m long

API type with floating roof

MODULE NO. M26
CATALYTIC CRACKING UNIT

Module area = 0.7 hectares: 120m x 60m

Process Input/Output:

The catalytic cracking unit is a typical Kellogg "side-by-side" type consisting of a reactor, regenerator, electrical precipitator, fractionator and various auxiliary units. The outlet gas from the precipitator with added gas or oil fuels the CO boiler.

The unit processes feed stock consisting of heavy gas oil streams from the vacuum stills or the Hydro-desulfurizer and decarb oil from the Solvent Decarbonizer. Streams leaving the main fractionator are a gasoline and lighter overhead product, a heavier side cut and a bottom gas oil cut part of which is recycled. The overhead is further processed to separate gas and gasoline cuts in a three column fractionating section. Heavier stocks are hydro-treated, cracking and/or used as blending stock.

A. FLUID CATALYTIC CRACKING UNIT 3,650 m^3/day

1. PUMPS AND COMPRESSORS

   a. See Standard Unit No. X26

2. VALVES AND FITTINGS

a. See Standard Unit No. X26

3. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Heater or Boiler	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H (steam superheater)	10	21.3	1.0
2	H	Each 48	39.0	2.4*
1	B (CO)	263	42.7	2.4

*Common stack

4. VESSELS

		DIMENSIONS (m)		
No.	Service	Diameter	Height	On a structure with an overall height of
1	Regenerator	13.0	10.7	30.5

B. COOLING TOWER

	DIMENSIONS (m)			
No.	Width	Length	Height	Throughput (metric tons/hr)
1	13.7	39.6	6.1	5,900

MODULE NO. M27
ACID GAS TREATING PLANT

Module area = 0.4 hectares: 84m x 48m

Process Input/Output:

Acid gas from several locations are treated to remove hydrogen sulfide

A. ACID GAS TREATING PLANT

See Standard Unit No. X46

MODULE NO. M28
SULFUR RECOVERY UNITS

Module area = 0.7 hectares: 120m x 54m

Process Input/Output:

H_2S is converted to molten sulfur

A. CLAUS SULFUR RECOVERY UNIT 46 metric tons/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X20

2. VALVES AND FITTINGS

   See Standard Unit No. X20

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Height (m)	Diameter (m)
1	Main reactor	11	No Stacks	
2	Auxiliary start-up burners	6		

B. BEAVON-STRETFORD TAIL GAS CLEANUP UNIT

See Standard Unit No. X47

MODULE NO. M29
GASOLINE SWEETENING UNIT

Module area = 0.5 hectares: 84m x 60m

A. GASOLINE SWEETENING UNIT 4,400 m^3/day

1. PUMPS AND COMPRESSORS
   - a. See Standard Unit No. X31
2. VALVES AND FITTINGS
   - a. See Standard Unit No. X31

MODULE NO. M30
FRACTIONATING UNIT

Module area = 0.3 hectares: 84m x 36m

A. FRACTIONATION UNIT 800 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Feed to depropanizer		A	C	M
1	Depropanizer reflux/ product	X	A	C	M
1	Debutanizer feed	X	A	C	M
1	Debutanizer feed/product		A	C	M
1	Debutanizer bottoms to storage	X	A	C	M

2. VALVES AND FITTINGS
   - a. Control Valves - 8
   - b. Process Valves - 560
   - c. Fittings - 1,880
   - d. Relief Valves - 10
   - e. Sample Connections - 10

MODULE NO. M31
CATALYTIC CRACKING UNIT

Module area = 1.4 hectares: 120m x 120m

Process Input/Output:

The catalytic cracking unit is a typical Kellogg "side-by-side type consisting of a reactor, regenerator, electrical precipitator, fractionator and various auxiliary units. The outlet gas from the precipitation with added gas or oil fuels the CO boiler.

The unit processes feed stock consisting of heavy gas oil streams from the vacuum stills and decarb oil from the Solvent Decarbonizer. Streams leaving the main fractionator are a gasoline and lighter overhead product, a heavier side cut and a bottom gas oil cut part of which is recycled. The overhead is further processed to separate gas and gasoline cuts in a three column fractionating section. Heavier stocks are hydro-treated, cracked and/or used as blending stock.

A. FLUID CATALYTIC CRACKING UNIT, 7,950 m^3/day

1. PUMPS AND COMPRESSORS
   a. See Standard Unit No. X26
2. VALVE AND FITTINGS
   a. See Standard Unit No. X26
3. COMBUSTION DEVICES
   a. Process Heaters and Boilers

No.	Heater or Boiler	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H (steam Superheater)	20	21.3	1.3
2	H	91	39.0	3.4*
1	B(CO)	612	45.9	3.1

*Common stack

4. VESSELS

No.	Service	Diameter	Height	On a structure with an overal height of
		DIMENSIONS		
1	Reactor	9.7	14.3	9.1
1	Regenerator	18.1	10.7	19.8
2	Hot catalyst storage	10.5	12.2	3.0

B. COOLING TOWERS

	DIMENSIONS (m)			
No.	Width	Length	Height	Throughput (metric + 1 hr)
2	13.7	39.6	6.1	5,900

MODULE NO. M32
FRACTIONATING UNIT

Module area = 0.4 hectare: 84m x 48m

A. FRACTIONATING UNIT 1,600 m^3/day

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Types	Seal Types
1	Feed tc depropanizer		A	C	M
1	Depropanizer reflux/product	X	A	C	M
1	Deisobutanizer feed	X	A	C	M
1	Deisobutanizer reflux/product		A	C	M
1	Deisobutanizer bottoms to storage	X	A	C	M

2. VALVES AND FITTINGS
   a. Control Valves - 8
   b. Process Valves - 560
   c. Fittings - 1,880
   d. Relief Valves - 10
   e. Single Connections - 10

MODULE NO. M33
HYDROGEN MANUFACTURING UNIT

Module area = 0.4 hectares: 84m x 48m

Process Input/Output:

Naphtha is used as feed in a steam reforming plant to product hydrogen

A. HYDROGEN MANUFACTURING UNIT, 1.4 x 10^6 m^3/day

1. PUMPS AND COMPRESSORS
    a. See Standard Unit No. X7
2. VALVES AND FITTINGS
    a. See Standard Unit No. X7
3. COMBUSTION DEVICES
    a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	264	30.9	1.9

MODULE NO. M34
ALKYLATION UNIT

Module area = 2.6 hectares: 174m x 150m

Process Input/Output

Feed to the alkylation unit consist of butane butylenes, propane propylene, isobutane and hydrofluoric acid. The products are the desired alkylate, propane and butane. The hydrofluoric acid is recycled.

A ALKYLATION UNIT 2,400 m^3/day

1. PUMPS AND COMPRESSORS
    a. See Standard Unit No. X48

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
3	Alkylate	34	FR	18.3	9.1	2,400	31,200
2	Alkylate	34	FR	13.7	7.6	1,100	14,300
4	Isobutane	500	P	13.7		1,350	17,550

C. STORM WATER HOLDING BASIN

15.2m wide x 30.5m long x 2.5m deep

MODULE NO. M35
NAPHTHA HYDROTREATER

Module area = 1.8 hectares: 180m x 102m

Process Input/Output:

This unit hydrotreats naphtha to provide a suitable desulfurized feed for a catalytic reformer.

A. NAPHTHA HYDROTREATER, 4,150 m^3/day

1. PUMPS AND COMPRESSORS
    a. See Standard Unit No. X2
2. VALVUES AND FITTINGS
    a. See Standard Unit No. X2
3. COMBUSTION DEVICES
    a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr.)	Stack Height (m)	Stack Diameter (m)
1	H	42	36.6	3.2
1	H	42	36.6	3.2

MODULE NO. M36
NAPHTHA HYDROTREATER

Module area = 1.8 heactares: 180m x 102m

Process Input/Output:

This unit hydrotreats naphttia to provide a suitable desulfurized feed for a catalytic reformer and also for the hydrogen manufacturing unit.

A. NAPHTHA HYDROTREATER, 4,600 m^3/day

1. PUMPS AND COMPRESSOR
   a. See Standard Unit No. X2
2. VALVES AND FITTINGS
   a. See Standard Unit No. X2
3. COMBUSTION DEVICES
   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height	Stack Height
1	H	47	36.6	3.2
1	H	50	36.6	3.2

MODULE NO. M37
CATALYTIC REFORMER

Module area = 1.7 hectares: 144m x 120m

Process Input/Output:

The feed to the reformer is desulfurized naphtha. The products in addition to reformate are hydrogen and light hydrocarbons.

A. CATALYTC REFORMER, 4,150 m^3/day

1. PUMPS AND COMPRESSORS
   a. See Standard Unit No. X24.

2. VALVES AND FITTINGS
   a. Control Valves - 17
   b. Process Valves - 1,190
   c. Fittings - 4,000
   d. Relief Valves - 17
   e. Sample Connections - 30

3. COMBUSTION DEVICES
   a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	55	36.6	2.3
1	H	133	36.6	2.5
1	H	69	36.6	2.0

MOUDLE NO. M38
CATALYTIC REFORMER

Module area = 2.1 hectares: 144m x 144m

Process Input/Output:

The feed to the reformer is desulfurized naphtha. The products in addition to reformate are hydrogen and light hydrocarbons.

A. CATALYTIC REFORMER, 4,150 m^3/day

1. PUMPS AND COMPRESSORS
    a. See Standard Unit No. X24
2. VALVES AND FITTINGS
    a. Control Valves - 17
    b. Process Valves - 1,190
    c. Fittings - 4,000
    d. Relief Valves - 17
    e. Sample Connections - 30
3. COMBUSTION DEVICES
    a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	55	36.6	2.3
1	H	133	36.6	2.5
1	H	69	36.6	2.0

MODULE NO. M39
STEAM GENERATING PLANT

Module area = 2.6 hectares: 180m x 144m

Process Input/Output:

A boiler house and several tanks are located in this area. The boiler house accommodates two foilers which have a common stack. Oil and gas are used as fuels.

A. STEAM GENERATING PLANT

1. COMBUSTION DEVICES

a. Process Heaters and Boilers

Quanity	Heater or Boiler	Design Heat Input (GJ/hr)	Stack Diameter (m)	Stack Height (m)
2	3	650 each	5.8	61.0

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	crude oil	28	FR	36.6	7.3	7,700	100,000
2	fuel oil	0.1	XR	15.2	7.3	1,300	16,900
2	water		XR	18.3	8.2	2,150	27,950

C. BUILDINGS

18.3m wide x 30.5m long x 12.2m high

MODULE NO. M40
FLARES

Module area = 3.4 hectares: 186m x 180

Process Input/Output:

The two flares in this area serving the catalytic cracking units are John Zink smokeless type with automatic steam control and a TV monitor.

A. FLARES

No.	Height (m)	Smokeless Capacity (m^3/hr)
1	45.7	7.9×10^4
1	45.7	4.8×10^4

MODULE NO. M41
PRODUCT STORAGE/TRUCK LOADING RACK

Module area = 6.7 hectares: 360m x 186m

A. PUMPS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Transfer		A	C	M
1	Transfer		C	C	M
1	Transfer		D	C	M

B. VALVES AND FITTINGS

a. Control Valves - none
b. Process Valves - 210
c. Fittings - 700
d. Relief Valves - none
e. Sample Connections - 10

C. TANKS

No.	Service	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Gas oil	0.1	XR	24.4	9.1	4,250	55,250
3	Commercial jet fuel	1.4	XR	37.2	12.2	13,250	172,250
1	Reformate	31	FR	37.2	12.2	13,250	172,250
1	Diesel fuel	0.1	XR	37.2	12.2	13,250	172,250
1	Fuel oil	0.1	XR	37.2	12.2	13,250	172,250
1	Diesel fuel	0.1	XR	21.3	12.2	4,350	56,550
2	Gas oil	0.1	XR	14.6	7.6	1,300	16,900
5	Reformer feed	39	FR	18.3	9.1	2,400	31,200
3	Propane-propylene	1,440	P	3.4	12.2	110	1,430

D. TRUCK LOADING RACK

7.0m side x 30.5m long x 4.6m high

MODULE NO. M42
PRODUCT STORAGE

Module area = 11.3 hectares: 540m x 210m

A. PRODUCT TRANSFER

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Transfer		C	C	M
1	Transfer		D	C	M
1	Transfer		B	C	M

2. VALVES AND FITTINGS

a. Control Valves - none

b. Process Valves - 170

c. Fittings - 600

d. Relief Valves - none

e. Sample Connections - 10

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
6	Crude	21	FR	36.6	12.2	12,800	166,400
2	Fuel oil	0.1	XR	36.6	12.2	12,800	166,400
2	Blending stock	50	FR	36.6	12.2	12,800	166,400
1	Commercial jet fuel	1.4	XR	36.6	12.2	12,800	166,400

C. COOLING TOWER

19.8m wide x 131m long x 9.1m high
17,700 metric ton/hr flow rate

MODULE M43
OIL-WATER SEPARATOR

Module area = 2.2 hectares: 180m x 120m

Process Input/Output:

The input to this area is wastewater from a process area. Output is handled further before final discharge.

A. API TYPE OIL-WATER SEPARATOR

Capacity 14,000 m^3/day
7.6m wide x 34.0m long
It is equipped with a floating roof.

MODULE NO. M44
PRODUCT STORAGE

Module area = 6.3 hectares: 300m x 210m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
3	Gasoline	80	XR	36.6	12.2	12,800	265,000
2	Gasoline	80	FR	36.6	12.2	12,800	230,000

MODULE NO. M45
PRODUCT STORAGE

Module area = 5.4 hectares: 300m x 180m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Gasoline	80	XR	36.6	12.2	12,800	265,000
2	Gasoline	80	FR	36.6	12.2	12,800	265,000

MODULE NO. M46
PRODUCT STORAGE

Module area = 6.3 hectares: 300m x 210m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Diesel fuel	0.1	XR	43.9	13.7	20,700	269,100
2	Fuel oil	0.1	XR	43.9	13.7	20,700	269,100
2	Residuum	below 0.1	XR	43.9	13.7	20,700	269,100

MODULE NO. M47
PRODUCT STORAGE

Module area = 9. hectares: 300m x 300m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
6	Gasoline	80	XR	36.6	12.2	12,800	265,000
3	Gasoline	80	FR	43.9	13.7	20,700	201,000

MODULE NO. M48
PRODUCT STORAGE

Module area = 12.1 hectares: 672m x 180m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Gasoline	80	FR	36.6	12.2	12,800	230,000
5	Fuel oil	below 0.1	XR	43.9	13.7	20,700	269,100

MODULE NO. M49
MATERIAL STORAGE

Module area = 3.0 hectares: 180m x 166m

This 3.0 hectares is set aside for such items as heater tubes, exchanger bundles, sheet steel, various sizes of pipe, etc. are stored in this area in stacks not over 2.4m high.

MODULE NO. M50
PRODUCT SHIPMENT

Module area = 1.5 hectares: 180m x 84m

A. PRODUCT TRANSFER

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Transfer		B	C	M
1	Transfer		D	C	M
1	Transfer		D	D	M

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Gasoline	80	FR	8.2	5.5	290	3,770
1	Jet fuel	0.1	XR	5.8	3.0	80	1,040
1	Fuel oil	below 0.1	XR	11.6	7.6	800	10,400
1	Kerosene	0.2	XR	6.4	3.0	95	1,235

C. TANK CAR LOADING RACK

See Standard Unit No. X36

MODULE NO. M51
FLARE

Module area = 2.7 hectares: 180m x 148m

Process Input/Output:

Input to flare is LPG product from storage and loading facilities.

A. FLARE

No.	Type	Height (m)	Capacity (m/hr)
1	Elevated smokeless	39.6	2,800

MODULE NO. M52
LPG TANK CAR LOADING RACK

Module area = 5.4 hectares: 300m x 180m

A. LPG LOADING

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
5	Butane		A	C	M
1	Propane	X	A	C	M

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
5	Butane	350	P	21.3	sphere	5,050	65,650
10	Propane	1,300	P	3.4	18.9 length	170	2,210

C. LPG TANK CAR LOADING RACK

3.0m wide x 30.0m long

MODULE NO. 53
FUTURE EXPANSION

Module area = 1.0 hectares: 174m x 60m

This vacant area is available for future plant expansion.

MODULE NO. M54
PRODUCT STORAGE

Module area = 2.7 hectares: 240m x 114m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Fuel oil	below 0.1	XR	36.6	12.2	12,800	166,400

MODULE NO. M55
BUILDINGS

Two buildings which are less than 9.0m high are located in this area.
Module area = 2.6 hectares: 240m x 108m

MODULE NO. M56
PRODUCT STORAGE

Module area = 3.1 hectares: 180m x 174m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Light furnace oil	0.1	XR	36.6	12.2	12,800	166,400

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Hydrotreated gas oil	0.1	XR	18.3	7.9	2,050	26,650

MODULE NO. M57
PRODUCT STORAGE

Module area = 4.8 hectares: 396m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m3)	Annual Throughput (m^3)
2	Light gas oil	10	XR	36.6	12.2	12,800	166,400
1	Hydrotreated furnace oil	0.1	XR	36.6	12.2	12,800	166,400
1	Light Naphtha	84	FR	36.6	12.2	12,800	166,400

MODULE NO. M58
ADMINISTRATION OFFICE

Module area = 4.1 hectares: 264m x 156m

A. BUILDING
61.0m long x 10.7m high

MODULE NO. M59
BUILDING

Module area = 3.2 hectares: 264m x 120m

A. BUILDING
17.7m wide x 38.1m long x 10.7m high

MODULE NO. M60
PRODUCT STORAGE/SHIPPING

Module area = 4.3 hectares: 360m x 120m

A. PRODUCT SHIPPING

1 PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
1	Benzene		C	C	M
1	Toluene		C	C	M
1	Xylene		D	C	M
1	Spare		-	C	M

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Benzene	23	FR	13.7	11.9	1,750	22,750
2	Benzene	23	FR	18.3	14.6	3,800	49,400
2	Toluene	7.6	XR	18.3	14.6	3,800	49,400
2	Toluene	7.6	XR	27.4	12.2	1,750	22,750

MODULE NO. M61
TRUCK LOADING RACK

Module area = 5.8 hectares: 480m x 120m

A. TRUCK LOADING

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	Gasoline	X	B	C	M
1	Vapor recovery compressor		A	R	P

2. VALVES AND FITTINGS

a. Control valves - none

b. Process valves - 170

c. Fittings - 590

d. Relief valves - 5

e. Sample Connections - 5

B. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
3	Gasoline	30	XR	9.4	6.1	420	5,460
1	Vapor	above 300	Sphere	6.4	--	135	1,755

C. TRUCK LOADING RACK
13.7m wide x 70.1m long x 6.1m high

MODULE NO. M62
PRODUCT STORAGE

Module area = 14.4 hectares: 480m x 300m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Heavy naphtha	39	FR	43.9	13.7	20,700	179,000
2	Gas oil	0.1	XR	43.9	13.7	20,700	179,000
4	Diesel fuel	0.1	XR	43.9	13.7	20,700	179,000

MODULE NO. M63
PRODUCT STORAGE

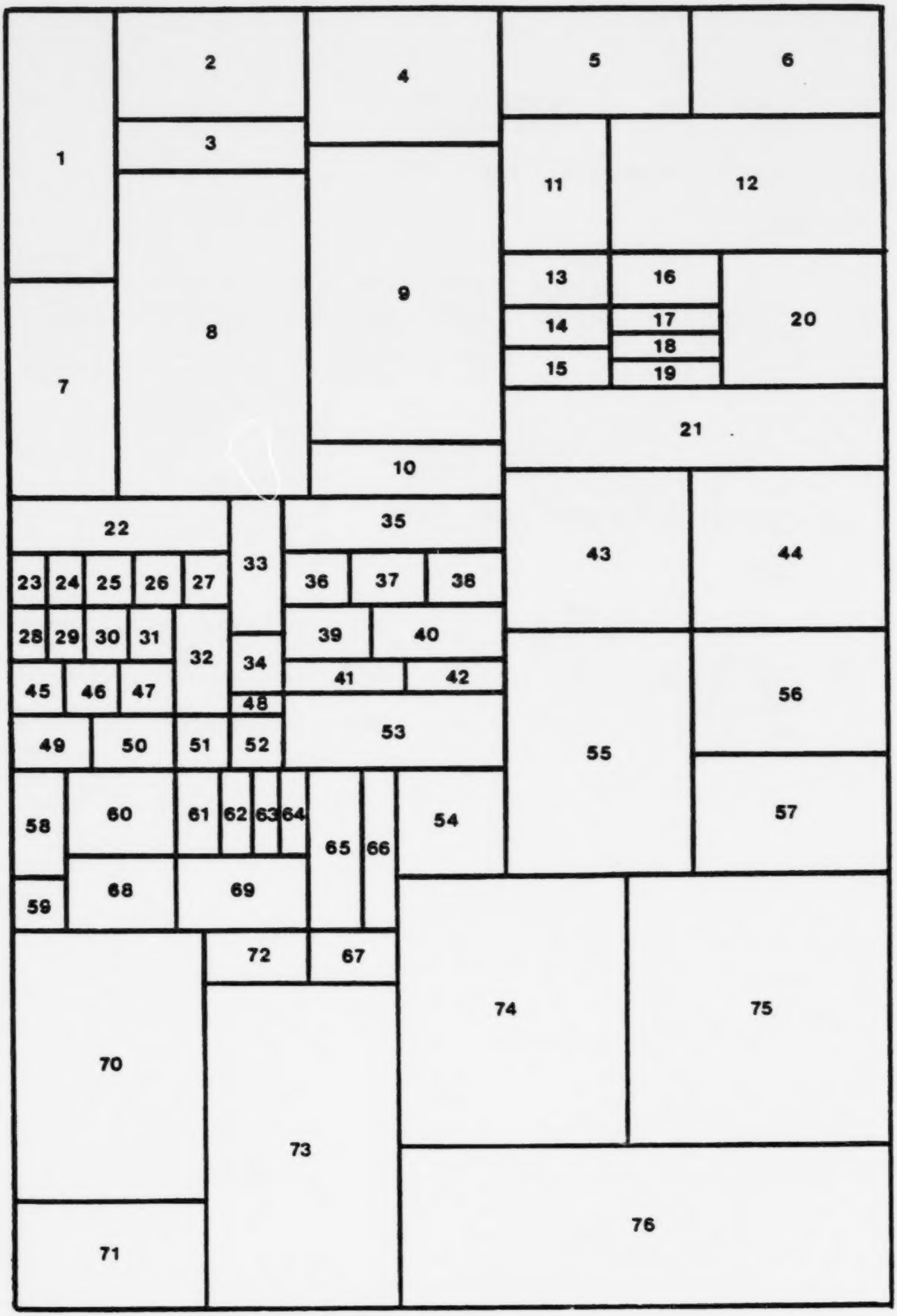
Module area = 14.4 hectares: 480m x 300m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
3	Light naphtha	84	FR	43.9	13.7	20,700	179,000
3	Commercial jet fuel	1.4	XR	43.9	13.7	20,700	179,000

LARGE CAPACITY EXISTING REFINERY

Scale 1 inch = 300 meters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LARGE CAPACITY EXISTING REFINERY MODULE KEY

Module No.	Description	Standard Unit Reference No.
L1	Buffer Zone	-
L2	Feedstock Storage	-
L3	Crude Oil Storage	-
L4	Feedstock Storage	-
L5	Feedstock Storage	-
L6	Crude Oil Storage	-
L7	Feedstock and Product Storage	-
L8	Crude, Feedstock, and Product Storage	-
L9	Crude, Feedstock, and Product Storage	-
L10	Oil-Water Separator	-
L11	Product Storage	-
L12	Product Storage	-
L13	Distillation and Gas Recovery Unit	X1
L14	Jet Hydrofiner/Catalytic Reformer	X4, X5
L15	Naphtha Nydrotreater	X2
L16	Hydrotreater	X6
L17	Hydrogen Manufacturing	X7
L18	Partial Oxidation Unit	X8
L19	Future Expansion	-
L20	Cooling Tower	-
L21	Flares	-
L22	Feedstock and Product Storage	-
L23	Naphtha Hydrotreater	X2
L24	Vacuum Gas Oil Unit	X9
L25	Benzene Fractionation	X10
L26	Steam Rerun Stills	X11
L27	Future Expansion	-
L28	Crude Distillation	X12
L29	Catalytic Reformer	X13
L30	Vacuum Residuum Desulfurizer	X14
L31	Hydrogen Manufacturing	X7
L32	Alkylation	X15, X16, X17
L33	Distillate Hydrodesulfurization	X18, X19, X20, X21, X22
L34	Sulfur Recovery	X20, X21, X22, X23
L35	Tanks/Cooling Towers	-
L36	Catalytic Reformer	X24
L37	Aromatics Extraction	X25
L38	Catalytic Cracking	X26
L39	Para-Xylene Plant	X27
L40	Delayed Coker	X28
L41	Barrel Storage	-

LARGE CAPACITY EXISTING REFINERY MODULE KEY

Module No.	Description	Standard Unit Reference No.
L42	Barrel Reconditioning	-
L43	Feedstock Storage	-
L44	Storm Water Impound Basin	-
L45	Warehouse	-
L46	Gas Holder/Blowdown Stack	
L47	Gas Holder/Blowdown Stack	-
L48	Fire Prevention Training Facility	-
L49	Oil-Water Separator	-
L50	Asphalt Plant	-
L51	Solvent Treating Plant/Boiler House	-
L52	SO_2 Treating Plant/Tanks	X29, X30
L53	Lube Oil Packaging	-
L54	Coke Storage	-
L55	Crude Oil Storage	-
L56	Feedstock Storage	-
L57	Tanks/Impound Basin	-
L58	Administration	-
L59	Oil-Water Separator	-
L60	Gasoline Sweetener/Crude Distillation	X12, X31
L61	Crude Distillation/Crude Desalter	X32, X33
L62	Specialty Crude Distillation	X34
L63	Specialty Crude Distillation/Condenser Box	X34
L64	Gasoline Fractionating Unit	X35
L65	Tank Loading/Truck Loading/Vapor Recovery	X36
L66	Buildings	-
L67	LPG Storage and Blending	-
L68	Vapor Recovery/Gasoline Rectifier/Tanks	X37, X39
L69	Main Pump House	X45
L70	Product Storage	-
L71	Wastewater Treatment	X40
L72	Building	-
L73	Product Storage	-
L74	Shops and Warehouse	-
L75	Crude Oil Storage	-
L76	Crude, Feedstock, and Product Storage	-

The oil/water separator in Module L10 treats aqueous discharge from Modules L1-L21

The separator located in Module L59 treats aqueous streams from Modules L58-L60, L68, L70, L71, and L73-L76.

The wastewater separator in Module L49 treats discharges from the remaining modules.

LARGE CAPACITY EXISTING REFINERY

CRUDE CHARGE RATE	40,000 m^3/day
BENZENE IMPORTED INTO REFINERY	195 m^3/day

PRODUCT SLATE

PRODUCT	PRODUCTION RATE m^3/day
Gasoline	24,248
Fuel oil	10,934
Jet fuel	7,120
Distillate fuel oil	7,929
Coke	3,427
Naptha	1,364
Toluene and xylene	1,143
Asphalt	722
Mixed olefins	462
Benzene	250
Lube oils	127
Kerosene	64
	57,790

NUMBER OF WHARF MODULES	8

MODULE NO. L1
BUFFER ZONE

Module area = 14.4 hectares: 600m x 240m

A. INTERMEDIATE STORM WATER STORAGE BASIN

66.6 m wide x 122 m long x 4 m deep

MODULE NO. L2
FEEDSTOCK STORAGE

Module area = 10.1 hectares: 420m x 240m

A. RESERVOIR FOR LIGHT RESIDUUM STORAGE

RVP 0.1 kPa

152.4 m wide x 243.8 m long

It extends 3 m above ground level

It is equipped with a fixed roof

Capacity 153,190m^3

MODULE NO. L3
CRUDE OIL STORAGE

Module area = 5.0 hectares: 420m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Crude	28.0	FR	35.	9.1	6,490	34,350

MODULE NO. L4
FEEDSTOCK STORAGE

Module area = 12.6 hectares: 420m x 300m

A. RESERVOIR FOR HEAVY RESIDUUM STORAGE

RVP 0.0007 kPa

122 m wide x 289.6 m long

It extends 3 m above ground level

It is equipped with a fixed roof

Capacity 49,500 m^3

MODULE NO. L5
FEEDSTOCK STORAGE

Module area = 10.1 hectares: 420m x 240m

A. RESERVOIR FOR LIGHT RESIDUUM STORAGE

RVP 0.1 kPa

91.44 m wide x 152.4 m long

It extends 3 m above ground level

It is equipped with a fixed roof

Capacity 79,500 m^3

MODULE NO. L6
CRUDE OIL STORAGE

Module area = 10.1 hectares: 420m x 240m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Crude	28.	FR	35.	9.1	6,490	84,350

MODULE NO. L7
FEEDSTOCK AND PRODUCT STORAGE

Module area = 11.5 hectares: 480m x 240m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Cycle oil	3.4	FR	41.1	14.6	20,460	266,000
1	Heavy gas oil	0.14	XR	35.	13.4	10,530	136,920
1	Heavy gas oil	0.14	XR	35.	13.4	10,285	133,710
1	Motor gasoline	80.	FR	42.	14.6	20,460	265,975
1	Cutter stock	0.14	XR	35.	10.7	10,285	133,710
3	Heavy gas oil	0.14	XR	36.6	12.5	13,215	171,800
1	Motor gasoline	80.	FR	35.	10.7	10,285	133,710
1	Cutter stock	0.14	XR	9.1	9.1	8,740	113,610
1	Heavy residuum	0.0007	XR	34.1	11.	10,310	134,065
1	Light naphtha	84.	FR	35.	10.7	10,285	134,065
1	Diesel	0.14	XR	36.6	12.5	13,215	171,800

MODULE NO. L8
CRUDE, FEEDSTOCK, AND PRODUCT STORAGE

Module area = 30.2 hectares: 720m x 420m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Reformate	31.	FR	35.	9.1	8,565	111,350
1	Commercial jet fuel	1.4	XR	30.5	12.2	7,460	97,000
2	Reformate	31.	FR	30.5	12.2	7,460	97,000
1	Crude oil	28.	FR	54.9	13.7	23,900	310,700
5	Motor gasoline	80.	FR	35.	10.7	10,285	133,700
1	Condensate	22.	FR	36.6	12.5	13,215	171,800
2	Light residuum	0.1	XR	36.6	12.5	13,215	171,800
1	Spent caustic	34.5	FR	29.	12.2	7,625	99,135
2	Diesel	0.14	XR	36.6	12.2	12,850	167,000
1	Reformate	31.	FR	45.7	13.7	15,750	204,550
1	Crude oil	28.	FR	35.	10.7	10,285	133,700
1	Crude oil	28.	XR	35.	9.1	8,565	111,350

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Jet fuel	17.	FR	35.	10.7	10,285	133,700
1	Stove oil	0.14	XR	45.7	13.7	15,730	204,500
1	Automotive diesel	0.14	XR	45.7	13.7	15,730	204,500
1	Furnace oil	6.	XR	45.7	13.7	15,730	204,500
1	Heavy gas oil	0.14	XR	45.7	13.7	15,730	204,500

MODULE NO. L9
CRUDE, FEEDSTOCK, AND PRODUCT STORAGE

Module area = 27.7 hectares: 660m x 420m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Reformate	31.	FR	35.	9.1	8,565	111,350
4	Gasoline	28.	FR	35.	9.1	8,565	111,350
1	Diesel	0.14	XR	35.	9.1	8,565	111,350
1	Recycle oil	3.4	FR	45.7	13.7	15,700	204,500
1	Crude	28.	FR	45.7	13.7	15,700	204,500
1	Crude	28.	FR	61.	19.2	53,300	692,900
1	Heavy gas oil	0.14	XR	35.	9.1	8,565	111,350
1	Jet fuel	17.	FR	35.	9.1	8,565	111,350
1	Jet fuel	17.	FR	45.7	13.7	15,730	204,530
1	Heavy gas oil	0.14	XR	35.	12.2	8,860	115,130
1	Commercial jet fuel	1.4	XR	35.	10.7	10,300	133,700
3	Commercial jet fuel	1.4	XR	35.	9.1	8,800	114,400
1	Heavy gas oil	0.14	XR	36.6	12.5	13,200	171,600
1	Thinner	1.4	FR	33.5	13.7	13,200	171,600
1	Heavy gas oil	0.14	XR	35.	10.7	10,285	134,065
1	Jet fuel	17.	FR	35.	9.1	8,565	111,350
1	Light residuum	0.1	XR	35.	9.1	8,565	111,350
1	Alkylate	34.	FR	36.6	12.5	13,200	171,600
1	Condensate	22.	FR	15.2	14.6	2,660	34,640
1	Commercial jet fuel	1.4	XR	35.7	12.8	13,200	171,600
1	Jet fuel	17.	FR	35.	10.7	10,285	134,065
2	Motor gasoline	80.	FR	35.	9.1	8,565	111,350

MODULE NO. L10
OIL-WATER SEPARATOR

Module area = 5.0 hectares: 420m x 120m

Process Input/Output:

The input to this module is the wastewater from a process area and surrounding area. The output is to Module No. 71, the wastewater treatment plant.

A. API TYPE OIL-WATER SEPARATOR

Capacity 14,560 m^3/day

7.62 m wide x 34 m long

It is equipped with a floating roof

MODULE NO. L11
PRODUCT STORAGE

Module area = 7.2 hectares: 300m x 240m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Motor gasoline	80.	FR	35.	9.1	8,850	115,000
1	Condensate	22.	FR	35.	9.1	8,850	115,000
2	Motor gasoline	80.	FR	36.6	9.1	15,419	200,448

MODULE NO. L12
PRODUCT STORAGE

Module area = 1.8 hectares: 600m x 300m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	Gasoline	74	FR	35.	9.1	8,850	115,000

MODULE NO. L13
DISTILLATION AND GAS RECOVERY UNIT

Module area = 2.9 hectares: 240m x 120m

Process Input/Output:

The input to this module is the catalytic cracker process gas and the stabilizer overhead gas. The output is to fuel gas, LPG storage and gasoline storage.

A. DISTILLATION AND GAS RECOVERY UNIT 1.5 x 10^6 m^3/day

See Standard Unit No. X1

MODULE NO. L14
JET HYDROFINER/CATALYTIC REFORMER

Module area = 2.2 hectares: 240m x 90m

Process Input/Output:

Input to this module is jet fuel and naphtha. Output is to product storage.

A. JET HYDROFINER 500 m^3/day

See Standard Unit No. X5

B. CATALYTIC REFORMER 4,800 m^3/day

See Standard Unit No. X4

MODULE NO. L15
NAPHTHA HYDROTREATER

Module area = 2.2 hectares: 240m x 90m

Process Input/Output:

The input to this module is from intermediate naphtha storage. The output is to catalytic reformers, gasoline blending, or hydrogen manufacture.

A. NAPHTHA HYDROTREATER 2,385 m^3/day

See Standard Unit No. X2

B. NH_3-H_2S RECOVERY PLANT

This is considered to be a chemical plant with few hydrocarbon emissions.

MODULE NO. L16
HYDROTREATER UNIT

Module area = 2.9 hectares: 240m x 120m

Process Input/Output:

The inputs to this module are from the catalytic cracker and from the vacuum distillation intermediate storage. Outputs go to a gas recovery section, to intermediate storage for further processing, and to gasoline blending.

A. HYDROTREATER UNIT 8,000 m^3/day

See Standard Unit No. X6

B. BUILDING

Control House - 9.1 m wide x 18.3 m long x 9.2 m high

MODULE NO. L17
HYDROGEN MANUFACTURING UNIT

Module area = 1.4 hectares: 240m x 60m

Process Input/Output:

The input to this module is from a natural gas source, refinery gas, propane, butane, and naphtha. The output is to units requiring hydrogen in the Isomax complex.

A. HYDROGEN MANUFACTURING UNIT 2,800,000 m^3/day

See Standard Unit No. X7

MODULE NO. L18
PARTIAL OXIDATION UNIT

Module area = 1.4 hectares: 240m x 60m

Process Input/Output:

> The input to this unit is fuel oil. The output is hydrogen to the units in the Isomax complex.

A. PARTIAL OXIDATION UNIT FOR HYDROGEN MANUFACTURE 85,000 m^3/day

See Standard Unit No. X8

MODULE NO. L19
FUTURE EXPANSION

The area of this module is 1.4 hectares. This is vacant area reserved for future plant expansion. Module dimensions are 240m x 60m.

MODULE NO. L20
COOLING TOWER

Module area = 10.8 hectares: 360m x 300m

Process Input/Output:

> The input to this module is warm water from a process complex. The output is cool water back to the complex.

A. BUILDING

23. m wide x 31. m long x 9. m high

B. COOLING TOWER

15. m wide x 55.1 m long x 6.4 high

10,180 T/hr water flow rate

MODULE NO. L21
FLARES

Module area = 15.1 hectares: 840m x 180m

Process Input/Output:

The input to this module is waste gas from the coker, catalytic cracking unit, and a process complex. The output is CO_2 and water vapor to the atmosphere.

A. FLARES

Quantity	Type	Diameter (m)	Height (m)	Capacity (kg/hr)
1	Elevated smokeless	1.22	51.0	313,000
2	Elevated smokeless	1.22	45.7	590,000

MODULE NO. L22
FEEDSTOCK AND PRODUCT STORAGE

Module area = 5.8 hectares: 480m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
4	Light gas oil	10.4	FR	23.8	10.7	4,750	61,850
2	Isobutane	503.	P	10.4	-	590	10,150
2	Gasoline	80	FR	15.2	14.6	2,650	34,450
1	Polymers	70	FR	7.3	10.7	450	5,800
1	Cumene	1.4	FR	9.1	9.1	600	7,700
2	Gasoline	80	FR	46.0	15.9	26.400	343,500
2	Natural gasoline	83	P	9.1	-	390	5,000
2	Recycle oil	3.4	FR	18.3	9.1	2,400	31,100
1	Cutter stock	.14	XR	18.3	9.1	2,400	31,000
2	Benzene	23.	FR	10.7	10.7	960	12,500
1	Isoparaffin	8.3	FR	10.7	10.7	960	12,500
1	Cumene	1.4	FR	10.7	10.7	960	12,500

MODULE NO. L23
NAPHTHA HYDROTREATER

Module area = 1.0 hectares: 120m x 84 m

Process Input/Output:

The input to this module is from intermediate naphtha storage. The output is to catalytic reformers, gasoline blending, or hydrogen manufacture.

A. NAPHTHA HYDROTREATER, 2,385 m^3/day

See Standard Unit No. X2

MODULE NO. L24
VACUUM GAS OIL UNIT

Module area = 1.0 hectares: 120m x 84m

Process Input/Output:

The input to this module is from crude units or storage. The output is to the fluid catalytic cracking unit or to diesel fuel.

A. VACUUM GAS OIL UNIT, 5,565 m^3/day

See Standard Unit No. X9

MODULE NO. L25
BENZENE FRACTIONATION

Module area = 1.3 hectares: 120m x 108m

Process Input/Output:

The input to this module is aromatics imported into the refinery. Outputs are separated aromatics to storage.

A. BENZENE FRACTIONATION, 800 m^3/day

See Standard Unit No. X10

MODULE NO. L26
STEAM RERUNSTILLS

Module area = 1.3 hectares: 120m x 108m

Process Input/Output:

The input to the module is from gas storage. The output goes to naphtha and gas oil bright stock storage.

A. STEAM RERUN STILLS, 2 stills, 2,000 m^3/day each

See Standard Unit No. X11

MODULE NO. L27
FUTURE EXPANSION

The area of this module is 1.2 hectares. This vacant area is available for future plant expansion. Module dimensions are 120m x 96m

MODULE NO. L28
CRUDE DISTILLATION UNIT

Module area = 1.0 hectare: 120m x 84m

Process Input/Output:

The input to this module is from crude storage. The output is to residuum storage and to intermediate storage for the various fractions that require further processing.

A. CRUDE DISTILLATION UNIT 23,850 m^3/day

See Standard Unit No. X12

MODULE NO. L29
CATALYTIC REFORMER

Module area = 1.0 hectares: 120m x 84m

Process Input/Output:

The input to this module is desulfurized naphtha. The output is to gasoline blending or an aromatic extraction unit.

A. CATALYTIC REFORMER, 3,200 m^3/day

See Standard Unit No. X13

MODULE NO. L30
VACUUM RESIDUUM DESULFURIZER

Module area = 1.0 hectares: 120m x 84m

Process Input/Output:

The input to this module is residuum from storage. The output is feed to the catalytic cracking unit.

A. VACUUM RESIDUUM DESULFURIZER 4,500 m^3/day

See Standard Unit No. X14

MODULE NO. L31
HYDROGEN MANUFACTURING UNIT

Module area = 1.2 hectares: 120m x 96m

Process Input/Output:

The input to this module is from a natural gas source, refinery gas, propane, butane, and naphtha. The output is to units requiring hydrogen.

A. HYDROGEN MANUFACTURING UNIT 2,800,000 m^3/day

See Standard Unit No. X7

MODULE NO. L32
H_2SO_4 ALKYLATION PLANT

Module area = 2.9 hectares: 240m x 120m

Process Input/Output:

Inputs are isobutane, butylenes, and sulfuric acid. Outputs are alkylate, spent acid and unreactive light hydrocarbons associated with the reactants.

A. H_2SO_4 ALKYLATION PLANT 800 m^3/day

See Standard Unit No. X15

B. PROPYLENE POLYMER PLANT 560 m^3/day

See Standard Unit No. X16

C. LPG PLANT 400 m^3/day

See Standard Unit No. X17

MODULE NO. L33
DISTILLATE HYDRODESULFURIZATION

Module area = 3.6 hectares: 300m x 120m

Process Input/Output:

Inputs are gas oil from first distillation crude units and acid gas from the sour water strippers. Output is to catalytic cracker feed and diesel fuel storage. Elemental sulfur is sent to H_2SO_4 plant.

A. HEAVY GAS OIL DISTILLATES HYDRODESULFURIZER 1,900 m^3/day

See Standard Unit No. X18

B. GAS OIL WASHER AND BRIGHTENER 1,500 m^3/day

See Standard Unit No. X19

C. SULFUR RECOVERY UNIT

See Standard Unit No. X20

D. TAIL GAS CLEAN-UP UNIT

See Standard Units No. X21 and No. X22

MODULE NO. L34
SULFUR RECOVERY

Module area = 1.6 hectares: 132m x 120m

Process Input/Output:

Inputs to the module come from processing modules producing sulfur containing gases. Output is sulfuric acid.

A. SULFUR RECOVERY UNIT 3 units, 136 metric tons/day each

See Standard Unit No. X20

B. TAIL GAS CLEAN-UP UNIT 3 units

See Standard Units No. X21 and No. X22

C. SULFURIC ACID PLANT 182 metric tons/day

See Standard Unit No. X23

MODULE NO. L35
TANKS/COOLING TOWERS

Module area = 5.8 hectares: 480m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dig (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	BT feed stock	31	FR	11.7	35.0	10,130	131,680
2	Aromatics	23	FR	10.0	11.5	954	12,400

B. COOLING TOWER
15 m wide x 73.6 m long x 9 m high
14,000 metric tons/hr water flow rate

C. COOLING TOWER
12.4 m wide x 31 m long x 6.4 m high
4,400 metric tons/hr water flow rate

D. GAS HOLDER
46 m diameter x 18.3 m high

E. BLOWDOWN STACK
1.83 m diameter x 29.3 m high

MODULE NO. L36
CATALYTIC REFORMER

Module area = 1.7 hectares: 144m x 120m

Process Input/Output:

The input is desulfurized naphtha. The output is gasoline for blending and aromatics recovery feedstocks.

A. CATALYTIC REFORMER 7,200 m^3/day

See Standard Unit No. X24

MODULE NO. L37
AROMATICS EXTRACTION UNIT

Module area = 2.0 hectares: 168m x 120m

Process Input/Output:

Benzene, toluene and xylenes (total of 600 m^3/day) can be produced depending upon the boiling range of the feed. Benzene can be charged to a cumene unit.

A. AROMATICS EXTRACTION UNIT 600 m^3/day

See Standard Unit No. X25

MODULE NO. L38
FLUID CATALYTIC CRACKING UNIT

Module area = 2.0 hectares: 168m x 120m

Process Input/Output:

Input is gas oil from desulfurization units. Output is catalytically cracked gasoline to refinery gasoline pool, cycle oils to fuel oil blending, and C_4 and lighter hydrocarbons to gas concentration unit.

A. FLUID CATALYTIC CRACKING UNIT 7,950 m^3/day

See Standard Unit No. X26

B. COOLING TOWER

15 m wide x 32 m long x 9 m high
6,410 metric tons/hr. water flow rate

C. COOLING TOWER

11.5 m wide x 36 m long x 9.2 m high
5,400 metric tons/hr. water flow rate

MODULE NO. L39
PARA-XYLENE PLANT

Module area = 2.3 hectares: 192m x 120m

Process Input/Output:

Input is xylene from the aromatics extraction unit. Output is para-xylene to finished product storage.

A. PARA-XYLENE PLANT 140 metric tons/day

See Standard Unit X27

MODULE NO. L40
DELAYED COKER PLANT

Module area = 3.5 hectares: 288m x 120m

Process Input/Output:

The input to the module is heavy residuum storage. The output is coke to the storage facility.

A. DELAYED COKER PLANT 7,950 m^3/day

See Standard Unit No. X28

MODULE NO. L41
BARREL STORAGE

This module is used for open storage of barrels on a paved surface. The area of the module is 1.9 hectares. Module dimensions are 264m x 72m.

MODULE NO. L42
BARREL RECONDITIONING

Module area = 1.6 hectares: 216m x 72m

A. SPRAY BOOTH

2.5 m wide x 3.0 m long x 3.0 m high
Paint usage is 0.02 m^3 of enamel per day

B. CAUSTIC PAINT STRIPPING BATH

2.5 m wide x 3.0 m long x 2.0 m deep

C. BUILDING

19.0 m wide x 46.0 m long x 11.0 m high

MODULE NO. L43
FEEDSTOCK STORAGE

Module area = 14.7 hectares: 408m x 360m

A. RESERVOIR FOR RESIDUUM STORAGE

RVP<0.1

152. m diameter

It extends 3. m above ground level

It is equipped with a fixed roof

Capacity 79,500 m^3

MODULE NO. L44
STORM WATER IMPOUND BASIN

Module area = 15.6 hectares: 432m x 360m

A. STORM WATER IMPOUND BASIN

145 m diameter at ground level

Capacity 75, 710 m^3

MODULE NO. L45
WAREHOUSE

Module area = 1.4 hectares: 120m x 120m

A. WAREHOUSE BUILDING

23. m wide x 122. m long x 12.2 m high

MODULE NO. L46
GAS HOLDER/BLOWDOWN STACK

Module area = 1.4 hectares: 120m x 120m

Process Input/Output:

The input to this module is gas from the catalytic reforming operations. The gas is recycled or sent to refinery make-up gas.

A. GAS HOLDER

46 m diameter x 18.3 m high

B. BLOWDOWN STACK

1.83 m diameter x 29.3 m high

MODULE NO. L47
GAS HOLDER/BLOWDOWN STACK

Module area = 1.4 hectares: 120m x 120m

Process Input/Output:

The input to this module is gas from the catalalytic reforming operations. The gas is recycled or sent to refinery make-up gas.

A. GAS HOLDER

46. m diameter x 18.3 m high

B. BLOWDOWN STACK

1.83 m diameter x 29.3 m high

MODULE NO. L48
FIRE PREVENTION TRAINING FACILITY

Module area = 0.6 hectares: 120m x 48m

A. FIRE PREVENTION TRAINING FACILITY

This facility consists of some small vessels, a pipe trench, and some small LPG sources which may be ignited and extinguished for practice purposes.

B. BUILDING

30.1 m wide x 30.1 m long x 9.1 m high

MODULE NO. L49
OIL-WATER SEPARATOR

Module area = 2.2 hectares: 180m x 120m

Process Input/Output:

The input to this module is the wastewater from a process area and surrounding area. The output is to Module No. 71, the wastewater treatment plant.

A. API TYPE OIL-WATER SEPARATOR

Capacity 130,000 m^3/day

38. m wide x 61. m long extending 3. m above ground level

It is equipped with a floating roof

MODULE NO. L50
ASPHALT PLANT

Module area = 2.2 hectares: 180m x 120m

Process Input/Output:

The input to this module is from specialty crude distillation units. The output is asphalt to product sales.

A. ASPHALT PROCESSING UNIT

1. COMBUSTION DEVICES

a. Fume Incinerator

Quantity	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	7.0	31.0	0.8

b. Asphalt Shell Still

		Dimensions (m)		
Number	Service	Diameter	Height	Length
4	Air blowing still*	3.0	10.2	10.0

* Mounted horizontally over a firebox with an overall height of 6.0 m.

Effluent discharges to fume incinerator

B. ASPHALT TRUCK LOADING RACK

	Dimensions (m)		
	Width	Length	Overall Height
Loading rack	3.0	20.0	7.0

C. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
9	asphalt emulsion	0.1	XR	6.0	9.0	250	-
6	asphalt	0.1	XR	12.2	9.1	1,050	-

D. BUILDING

40. m wide x 80. m long x 10. m high

MODULE NO. L51
SOLVENT TREATING PLANT/BOILER HOUSE

Module area = 1.4 hectares: 120m x 120m

A. SOLVENT TREATING PLANT

1. PUMPS AND COMPRESSORS

Service	Spare	RVP Class	Pump Type	Seal Type
Transfer		B	R	P
Cresylic acid		D	R	P
Aliphatic acid		D	R	P

2. VESSELS

No.	Service	Dia (m)	Ht. (m)	Open	Covered
3	Agitators	20.0	10.0	X	
2	Agitators	20.0	10.0		X

3. TANK CAR LOADING RACK

Two loading spots for aliphatic and cresylic acids.

4. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capa-city (m^3)	Annual Throughput (m^3)
2	Boiler Water	---	Open	2.5	3.0	15.	----
1	Cresylicacid	0.1	XR	10.0	10.0	800.	----
1	Aliphaticacid	0.1	XR	10.0	10.0	800.	----

B. BOILER HOUSE

1. COMBUSTION DEVICES

a. Process Heaters and Boilers

No.	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	B	25.	55.*	3.7
2	B	53.	55.*	3.7
1	B	109.	55.*	3.7
3	B	187.	55.**	3.7
1	B	197.	55.**	3.7

* Boilers share common stack

** Boilers share common stack

2. BUILDING

31.0 m wide x 62.0 m long x 12.0 m high

MODULE NO. L52
SO_2 TREATING PLANT/TANKS

Module area = 1.4 hectares: 120m x 120m

Process Input/Output:
The major unit is a treating plant for aromatic removal from various streams from first distillation by a selective solvent, SO_2. The aromatic product goes to an aromatic recovery unit or gasoline blending. The raffinates go to jet fuel, diesel fuel, and thinners.

A. SO_2 TREATING PLANT 1,300 m^3/ day

See Standard Unit No. X29

B. ACID TREATING PLANT 447 m^3/day

See Standard Unit No. X30

C. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
2	kerosene	0.2	XR	9.8	10.7	800	10,400
4	diesel fuel	0.1	XR	11.0	10.7	1,000	13,000
4	spray oil	0.2	XR	11.0	9.1	850	11,050
3	kerosene	0.2	XR	14.6	12.2	2,050	26,650
1	extract	0.5	XR	7.3	9.1	380	4,940

MODULE NO. L53
LUBRICATING OIL PACKAGING

Module area = 8.1 hectares: 480m x 168m

		Dimensions (m)		
		Width	Length	Height
A.	BUILDING FOR CAN FILLING	15.0	120.0	10.7
B.	BUILDING FOR BARREL FILLING	15.0	120.0	10.7
C.	WAREHOUSE	25.0	60.0	10.7
D.	PACKAGE WAREHOUSE	30.0	140.0	10.7

MODULE NO. L54
COKE STORAGE AND HANDLING

Module area = 5.8 hectares: 240m x 240m

Process Input/Output:
The input is coke from the delayed coker.
The output is to loading and shipping facilities offsite

A. COKE STORAGE BUILDING

30.5 m wide x 30.5 m long x 15.2 m high.

B. STRUCTURE FOR CONVEYING EQUIPMENT FROM THE COKER

Associated with the Coke Storage Building is the structure for the conveying equipment from the coker. Steel frame work 6 m wide x 488 m long extending 366 m with a height of 6 m. The last 122 m rises diagonally to a height of 21.3 m.

MODULE NO L55
CRUDE OIL STORAGE

Module area = 22.0 hectares: 540m x 408

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (M^3)	Annual Throughput (m^3)
1	crude	28	FR	70.	19.5	75,350	2.257,000

MODULE NO. L56
FEEDSTOCK STORAGE

Module area = 11.9 hectares: 432m x 276m

A. RESERVOIR FOR LIGHT RESIDUUM STORAGE

RVP 0.1 kPa
152.4 m wide x 243.8 m long
It extends 3 m above ground level
It is equipped with a fixed roof
capacity 153,190m^3

MODULE NO. L57
TANKS/IMPOUND BASIN

Module area = 11.4 hectares: 432m x 264m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	crude	28.	FR	79.2	19.5	96,100	2,884,000
1	light residium	0.1	FR	79.2	19.5	95,100	2,884,000

B. IMPOUND BASIN

22.9 m wide x 305 m long at ground level

MODULE NO. L58
ADMINISTRATIVE BUILDING

Modules area = 2.9 hectares: 240m x 120m

A. ADMINISTRATIVE BUILDING

30.5 m wide x 96.0 long x 10.7 m high

MODULE NO. L59
OIL-WATER SEPARATOR

Module area = 1.4 hectares: 120m x 120m

Process Input/Output:

The input to this module is the wastewater from a process area and surrounding area. The output is to Module No. 71, the wastewater treatment plant.

A. API TYPE OIL-WATER SEPARATOR

Capacity 26,000 m^3/day
15.2 m wide x 30.5 m long extending 1.0 m above ground level
It is equipped with a floating roof

MODULE NO. L60
GASOLINE SWEETENER/CRUDE DISTILLATION-UNIT

Module area = 4.6 hectares: 240m x 192m

Process Input/Output

The input to the module is from crude storage. The output goes to intermediate and residuum storage.

A. GASOLINE SWEETENER 4,450 m^3/day
See Standard Unit No. x31

B. CRUDE DISTILLATION 23,850 m^3/day
See Standard Unit No. x12

MODULE NO. L61
CRUDE DISTILLATION UNIT/CRUDE DESALTER

Module area = 1.8 hectares: 192m x 96m

Process Input/Output

The input to the module is from crude storage. The output goes to intermediate storage.

A. CRUDE DISTILLATION UNIT 6,360 m^3/day
See Standard Unit X32

B. CRUDE DESALTING UNIT 6,400 m^3/day
See Standard Unit X33

MODULE NO. L62
SPECIALTY CRUDE UNIT

Module area = 1.4 hectares: 192m x 72m

Process Input/Output

The input to the module is from crude storage. The output goes to residuum and intermediate storage and to an asphalt processing module.

A. SPECIALTY CRUDE UNIT 1,530 m^3/day
See Standard Unit X34

MODULE NO. L63
SPECIALTY CRUDE UNIT/CONDENSER BOX

Module area = 1.2 hectares: 192m x 60m

Process Input/Output

The input to the module is from crude storage. The output goes to residuum and intermediate storage and to an asphalt procesing module.

A. SPECIALTY CRUDE UNIT 1,530 m^3/day
See Standard Unit No. X34

B. OVERHEAD CONDENSER BOX, 305 m^3/day

The box has dimensions of 10 m wide x 20 mlong x 3 m deep and is mounted on a structure 6 m high giving an overall height of 9 m.

MODULE NO. L64
GASOLINE FRACTIONATING UNIT

Module area = 1.2 hectares: 192m x 60m

Process Input/Output

The input to the module is straight run naphtha from crude distillation units. The output goes to the catalytic reformer module, to gasoline blending, and to the refinery gas system.

A. GASOLINE FRACTIONATING UNIT 9,500 m^3/day
See Standard Unit No. X35

MODULE NO. L65
TANK LOADING/TRUCK LOADING/VAPOR RECOVERY

Module area = 4.3 hectares: 360m x 120m

Process Input/Output

The input to the module come from product storage.

A. TANK CAR LOADING RACK FACILITY
See Standard Unit No. X36

B. TRUCK LOADING RACK FACILITY
See Standard Unit No. X36

C. VAPOR RECOVERY PACKAGE UNIT ABSORPTION TYPE
1,000 kg/hr
See Standard Unit No. X36

MODULE NO. L 66
BUILDINGS

Module area = 2.6 hectares: 360m x 72m

	Dimensions (m)		
	Width	Length	Height
A. BUILDING	38.0	61.0	15.2
B BUILDING	22.9	38.0	9.1

MODULE NO. L67
LPG STORAGE AND BLENDING

MODULES = 2.3 hectares: 192m x 120m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Height (m)	Length (m)	Capacity (m^3)	Annual Throughput (m^3)
9	LPG	828	p*	4.4	36.6	557	723.5

*Horizontal cylindrical pressure tanks mounted on saddles 3.66 m high.

B. TANK CAR LOADING FACILITY

The loading rack is 36.6 m long and 3.8 m high. There are 2 spots on each side.

C. TRUCK LOADING FACILITY

The loading rack is 18.3 m long and 3.8 m high

MODULE NO. L68
VAPOR RECOVERY/GASOLINE RECTIFIER UNIT/TANKS

Module area = 4.0 hectares: 240m x 168m

Process Input/Output

Input to the vapory recovery unit come from fixed roof storage tanks; output goes to crude distillation unit. Input to the gasoline rectifier unit come from the atmospheric crude distillation; output goes to gasoline storage and to the gas concentration unit.

A. VAPOR RECOVERY PLANT

See Standard Unit X37

B. GASOLINE RECTIFIER UNIT

See Standard Unit X39

C. TANKS

				Dimensions (m)			
Quantity	Stock	RVP Estimate	Tank Type	Diameter	Height	Capacity	Annual throughout
1	gasoline	69	FR	23	10.7	4,270	55,460
1	alkylate	34	FR	23	10.7	4,270	55,460

MODULE NO. L69
MAIN PUMP HOUSE

Module area = 4.8 hectares: 288m x 168m

Process Inputs/Outputs

The input to the module comes from processing or tankage modules. The output from the module goes to intermediate or product storage.

A. MAIN PUMP HOUSE

See Standard Unit No. X45

B. TANKS

No.	Stock	Estimate	Type	Diameter	Height	Capacity	Annual Throughput
1	motor gasoline	69	FR	29	9.1	5740	79,620
2	recycle oil	0.14	FR	18.3	9.1	2390	31,100
2	gas oil	0.14	FR	18.3	9.1	2390	31,100

MODULE NO. L70
PRODUCT STORAGE

Module area = 25.2 hectares: 600m x 420m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughout (m^3)
2	JP-4	17.	FR	36.0	10.7	10,315	134,090
2	JP-4	17.	FR	35.0	9.1	8,816	114,607
2	diesel	0.14	XR	30.5	9.1	6,768	87,990
1	emulsion	-	XR	27.4	10.7	5,868	75,777
1	diesel	0.14	XR	27.4	10.7	5,880	75,609
1	JP-4	17.	FR	35.0	10.7	9,462	123,001
3	motor gasoline	69.	FR	18.3	9.1	3,304	42,948
1	JP-4	17.	FR	35.0	9.1	8,816	114,607
2	JP-4	17.	FR	35.0	9.7	10,286	133,708
1	pentane	108.	FR	30.5	12.2	10,711	139,232
1	diesel	0.14	XR	35.1	10.7	10,356	134,626
1	JP-4	17.	FR	27.4	9.1	4,840	62,917
1	motor gasoline	69.	FR	35.0	10.7	9,611	124,935
1	motor gasoline	69.	FR	18.3	9.1	3,304	42,949
1	water	-	XR	27.4	9.1	4,840	62,977

MODULE NO. L71
WASTEWATER TREATMENT PLANT

Module area = 10.1 hectares: 420m x 240m

A. WASTEWATER TREATMENT PLANT 20,000 m^3/day

See Standard Unit No. X40

MODULE NO. L72
BUILDING

Module area = 2.7 hectares: 228m x 120m

A. BUILDING

7.62 m wide x 61. 0 m long x 90 m high

MODULE NO. L73
PRODUCT STORAGE

Module area = 30.2 hectares: 720m x 420m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	fuel oil	0.14	XR	36.6	12.8	16,638	216,304
2	fuel oil	0.14	XR	35.0	9.1	8,565	111,345
1	gas oil	10.4	FR	35.0	10.7	10,286	133,720
1	fuel oil	0.14	XR	35.0	10.7	10,020	130,258
1	recycle oil	10.4	FR	35.0	10.7	10,286	133,720
1	cutter stock	0.7	XR	35.0	10.7	10,020	130,258
1	residuum	0.1	XR	27.4	6.0	1,225	15,920
2	cutter stock	0.7	XR	27.4	6.0	1,225	15,920
1	fuel oil	0.14	XR	30.5	12.2	10,665	138,645
1	fuel oil	0.14	XR	42.7	14.6	21,020	271,780
1	naphtha	84.	FR	12.2	7.62	800	10,400
1	fuel oil	0.14	XR	36.6	14.0	13,440	174,710
1	motor gasoline	69.	FR	13.7	12.2	1,070	13,910
1	thinner	1.4	XR	8.2	4.6	180	2,335
1	DEA	34.	FR	8.2	4.6	180	2,335
1	line wash	34.	FR	8.2	4.6	180	2,335
1	olefin	1,585.	P*	2.44	--	53.5	695

*Spherical pressure tank

MODULE NO. L74
SHOPS AND WAREHOUSE

Module area = 30.2 hectares: 600m x 504m

	Dimension (m)		
	Width	Length	Height
A. BUILDING	38.1	76.2	12.2
B. BUILDING	30.5	91.4	12.2

MODULE NO. L75
CRUDE OIL STORAGE

Module area = 34.6 hectares: 600m x 576m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia. (m)	Ht. (m)	Capacity (m^3)	Annual Throughput (m^3)
3	crude	28.	FR	70.1	19.5	73,288	219,864
1	crude	28.	FR	73.8	19.5	81,135	243,404
1	crude	28.	FR	67.	14.6	49,871	149,613
2	crude	28.	FR	69.2	18.3	66,927	200,780

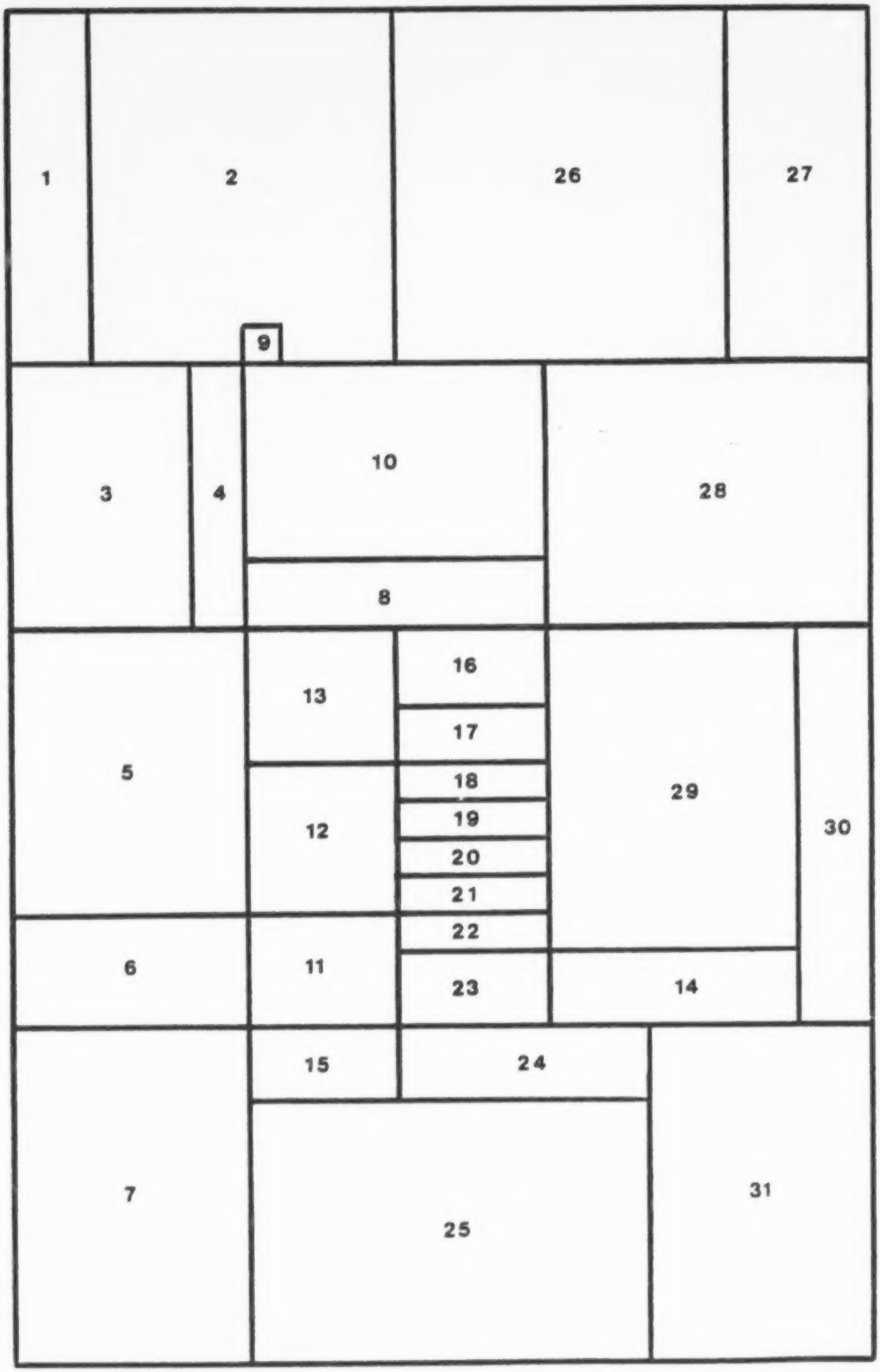
MODULE NO. L76
CRUDE, FEEDSTOCK AND PRODUCT STORAGE

Module area = 38.9 hectares: 1080m x 360m

A. TANKS

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	fuel oil	0.14	XR	61.	14.6	42,663	554,619
3	fuel oil	0.14	XR	61.	18.3	53,329	693,273
1	crude	28.	FR	30.5	14.6	9,999	129,987
6	motor gasoline	69.	FR	45.7	13.7	22,472	292,137
1	aromatics	11.	FR	30.5	17.0	12,444	161,764
3	crude	28.	FR	47.2	14.6	25,625	25,625
1	gas oil	10.4	FR	33.5	14.0	12,906	167,773
5	motor gasoline	69.	FR	33.5	14.0	12,906	167,773
1	pentane	108.		20.4	14.6	4,788	62,242
1	motor gasoline	69.	FR	27.4	14.6	8,639	112,311
1	JP-4	17.	FR	27.4	14.6	6,826	88,743
1	toluene	7.6	FR	20.4	14.6	4,788	62,242
1	polymers	70.	FR	20.4	14.6	4,788	62,242
1	benzene	23.	FR	20.4	14.6	4,788	62,242
1	motor gasoline	69.	FR	27.4	14.6	6,826	88,743
1	pentane	108.	FR	17.4	14.0	2,356	30,629
1	motor gasoline	69.	FR	27.4	14.6	8,640	112,310
1	solvent	0.7	XR	27.4	14.6	8.640	112,310
1	thinner	1.2	XR	27.4	14.6	8,640	112,310
1	cumene	1.4	FR	24.3	14.6	6,812	88,554
1	motor gasoline	69.	FR	24.3	14.6	6,812	88,554

NEW REFINERY
Scale 1 inch = 240 meters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NEW REFINERY MODULE KEY

Module No.	Description	Standard Unit Reference No.
N1	Future Expansion	-
N2	Product Storage	-
N3	Product Storage	-
N4	Tank Car Loading/Vapor Recovery	X36
N5	Feedstock Storage	-
N6	Delayed Coker/Coke Storage	X28
N7	Flares	-
N8	Gasoline Sweetening	X31
N9	Pumping Station	-
N10	Future Expansion	-
N11	Sour water/Oxidizer/Acid-gas treating/Sulfur recovery	X41, X46, X20
N12	Catalytic Cracking	X26
N13	Alkylation	X26
N14	Truckloading/Vapor Recovery	X36
N15	Cooling Towers	-
N16	Catalytic Reformer	X24
N17	Aromatics Extraction	X25
N18	Thermal Hydro Dealkylation	X43
N19	Heavy Gas Oil Desulfurizer	X18
N20	Naptha Desulfurizer	X44
N21	Gas Oil Hydro Desulfurizer	X9
N22	Distillation/Gas Recovery	X1
N23	Crude Distillation/Crude Desalting	-
N24	Maintenance Shops	-
N25	Wastewater Treatment	X40
N26	Product Storage	-
N27	Future Expansion	-
N28	Crude Oil Storage	-
N29	Feedstock Storage	-
N30	Administration	-
N31	Future Expansion	-

NEW REFINERY

CRUDE CHARGE RATE	40,000 m^3/day

PRODUCT SLATE PRODUCT	PRODUCTION RATE (m^3/day)
Gasoline	22,340
#2 Fuel Oil	12,201
Jet fuel	2,882
Gas oil	2,165
Benzene	760
Xylene	610
Carbon black feed stock	590
Natural gasoline	253
Naptha	135
Toluene	64
	42,000

NUMBER OF WHARF MODULES	4

MODULE NO. N1
FUTURE EXPANSION

Module area = 7.4 hectares: 564m x 132m

This area is reserved for future expansion.

MODULE NO. N2
PRODUCT STORAGE

Module area = 2.7 hectares: 564m x 480m

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Diesel fuel	0.14	XR	25.9	14.6	7,692	100,000
1	Kerosene	0.21	XR	51.8	14.6	30,787	400,231
1	#2 fuel oil	0.14	XR	51.8	14.6	30,787	400,231
3	#2 fuel oil	0.14	XR	64.0	14.6	46,968	610,584
2	#6 fuel oil	0.0007	XR	51.8	14.6	31,002	403,026
2	JP-4	17.	FR	51.8	14.6	31,002	418,374

MODULE NO. N3
PRODUCT STORAGE

Module area = 12.1 hectares: 420m x 288m

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Benzene	23.	FR	38.1	14.6	16,646	216,398
2	Benzene	23.	FR	12.2	12.2	1,427	158,200
1	Toluene	7.6	FR	25.9	14.6	7,692	29,730
1	Xylene	3.4	FR	25.9	14.6	7,692	100,000
2	Xylene	3.4	FR	12.2	12.2	1,427	90,272

MODULE NO. N4
TANK CAR LOADING/VAPOR RECOVERY PACKAGE UNIT

Module area = 3.5 hectares: 420m x 84m

Process Input/Output:

The input to the module is from product storage.

A. TANK CAR LOADING FACILITY

See Standard Unit No. X36

B. VAPOR RECOVERY PACKAGE UNIT - ABSORPTION TYPE 1000 Kg/hr

See Standard Unit No. X36

MODULE NO. N5
FEEDSTOCK STORAGE

Module area = 16.7 hectares: 456m x 366m

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Coker gas oil	0.7	XR	19.8	12.2	3,757	48,841
1	Coker gas oil	0.7	XR	51.8	14.6	30,769	400,000
1	Coker feedstock	0.7	XR	38.1	14.6	11,742	152,646
1	Coker feedstock	0.7	XR	32.0	14.6	30,769	400,000
2	Alkylate	34.	FR	38.1	14.6	16,646	216,398
3	Alkylation feed	310.	P*	16.6	-	2,400	31,200
1	Propane	1303.	P*	14.5	-	1,600	20,800
9	Iso-butane	503.	P*	14.5	-	1,600	20,800
4	Butane	352.	P*	16.6	-	2,400	31,200

*Spherical pressure vessels

MODULE NO. N6
DELAYED COKER/COKE STORAGE

Module area - 6.6 hectares: 366m x 180m

Process Input/Output:

The input to the module is from intermediate storage. The output, which is petroleum coke, leaves the refinery.

A. DELAYED COKER PLANT 7950 m^3/day

See Standard Unit No. X28

B. COKE STORAGE BUILDING

This building is 30m wide x 30m long x 15m high.

MODULE NO. N7
FLARES

Module area = 19.8 hectares: 540m x 366m

Process Input/Output:

The input to the module is from the refinery blowdown and emergency gas system.

A. ELEVATED FLARES

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)
1	Smokeless	650	38.1
1	Smokeless	345	47.3

MODULE NO. N8
GASOLINE SWEETENING UNIT

Module area = 5.2 hectares: 480m x 180m

Process Input/Output:

The input to the module is sulfur-containing gasoline. The output goes to gasoline blending.

A. GASOLINE SWEETENING UNIT 4,450 m^3/day

See Standard Unit No. X31

MODULE NO. N9
PUMPING STATION

Module area = 0.4 hectares: 60m x 60m

Process Input/Output:

The input to the module comes from processing modules. The output goes to intermediate and product storage.

A. PUMPING STATION

1. PUMPS AND COMPRESSORS

No.	Service	Spare	RVP Class	Pump Type	Seal Type
3	product transfer	x	B	R	P
4	product transfer	2x	B	C	M
2	product transfer	x	C	R	P
4	product transfer	2x	C	C	M
2	product transfer	x	D	C	M
3	product transfer	x	D	R	P

2. VALVES AND FITTINGS

a. Process Valves - 1,260
b. Fittings - 4,230
c. Relief Valves - 18
d. Sample Connections - 18

MODULE NO. N10
FUTURE EXPANSION

Module area = 14.9 hectares: 480m x 312m

This module area is reserved for future refinery expansion.

MODULE NO. N11
SOUR WATER OXIDIZER/ACID GAS TREATING/ SULFUR RECOVERY UNITS

Module area = 4.3 hectares: 240m x 180m

Process Input/Output:

The inputs to the sourwater oxidizer come from aqueous streams from the processing units; output is discharged to crude desalter. The inputs to the acid gas and sulfur recovery units are the refinery gas system; outputs are treated gas back to the refinery gas system and elemental sulfur to storage.

A. SOUR WATER OXIDIZER 950 m^3/day

See Standard Unit No. X41

B. ACID GAS TREATING PLANT

See Standard Unit No. X46

C. TWO SULFUR RECOVERY UNITS (2 STAGE CLAUS)
150 metric tons/day each

See Standard Unit No. X20

MODULE NO. N12
FLUID CATALYTIC CRACKING

Module area = 5.8 hectares: 240m x 240m

Process Input/Output:

The inputs to the module come from the delayed coker, crude distillation, and catalytic hydrodesulfurization units. Output is to the refinery fuel system and to product blending and storage.

A. FLUID CATALYTIC CRACKING UNIT 12,000 m^3/day

See Standard Unit X26.

MODULE NO. N13
HF ALKYLATION

Module area = 5.8 hectares: 240m x 240m

Process Input/Output:

The inputs to the module are iso-butane and mixed olefins. The output, alkylate, goes to gasoline blending.

A. ALKYLATION UNIT, HYDROFLUORIC ACID 5,000 m^3/day

See Standard Unit No. X48

MODULE NO. N14
TRUCK LOADING/VAPOR RECOVERY

Module area = 4.8 hectares: 396m x 120m

Process Input/Output:

The input comes from product storage.

A. TRUCK LOADING FACILITY

See Standard Unit No. X36

B. VAPOR RECOVERY PACKAGE SYSTEM - ABSORPTION TYPE 1,000 Kg/hr

See Standard Unit No. X36

MODULE NO. N15
COOLING TOWERS

Module area = 2.9 hectares: 240m x 120m

Process Input/Output:

The input to the module is cooling water.

A. TWO COOLING TOWERS

Each 14.6m wide x 76.6m long x 9.0m high
Each 14,000 m^3/hr - water flow rate

B. COOLING TOWER

14.6m wide x 32.5m long x 9.0m high
5,200 m^3/hr - water flow rate

MODULE NO. N16
CATALYTIC REFORMER

Module area = 3.0 hectares: 240m x 126m

Process Input/Output:

The input to the module is desulfurized naphtha from intermediate storage. The output goes to gasoline blending and to intermediate storage for feed to the aromatics recovery unit.

A. CATALYTIC REFORMER 6,000 m^3/day

See Standard Unit No. X24

MODULE NO. N17
AROMATICS EXTRACTION

Module area = 2.2 hectares: 240m x 90m

Process Input/Output:

The input to this module comes from intermediate storage of catalytic reformate. The outputs, benzene, toluene, and xylene go to product storage.

A. AROMATICS EXTRACTION UNIT 1,800 m^3/day

1. PUMPS AND COMPRESSORS

   See Standard Unit No. X25

2. VALVES AND FITTINGS

   See Standard Unit No. X25

3. COMBUSTION DEVICES

   a. Process Heaters and Boilers

Quantity	Type	Design Heat Input (GJ/hr)	Stack Height (m)	Stack Diameter (m)
1	H	210	41.7	3.5

MODULE NO. N18
THERMAL HYDRODEALKYLATION

Module area = 1.4 hectares: 240m x 60m

Process Input/Output:

The input to the module is toluene from storage. The output is benzene which is sent to storage.

A. THERMAL HYDRODEALKYLATION 570 m^3/day

See Standard Unit No. X43; Design Heat Input is 46.0 (GJ/hr)

MODULE NO. N19
HEAVY GAS OIL DESULFURIZATION

Module area = 1.4 hectares: 240m x 60m

Process Input/Output:

The input to the module comes from the delayed coker and crude distillation units. The output goes to the catalytic cracking unit.

A. HEAVY GAS OIL DESULFURIZER 1,900 m^3/day

See Standard Module No. X18

MODULE NO. N.20
NAPHTHA HYDRODESULFURIZER

Module area = 1.4 hectares: 240m x 60m

Process Input/Output:

The inputs to the module are sulfur-containing naphthas. The output goes to gasoline blending and to the catalytic reformer unit.

A. NAPHTHA HYDRODESULFURIZER 4,300 m^3/day

See Standard Unit No. X44

MODULE NO. N21
GAS OIL HYDRODESULFURIZER

Module area = 1.4 hectares: 240m x 60m

Process Input/Output:

The inputs are light gas oils, kerosene and jet fuels. Output is to product storage.

A. GAS OIL HYDRODESULFURIZER 5,565 m^3/day

See Standard Module No. X9

MODULE NO. N22
DISTILLATION/GAS RECOVERY UNIT

Module area - 1.4 hectares: 240m x 60m

Process Input/Output:

The input to the module is light ends from processing units. The outputs are sent to the refinery gas system and to product storage.

A. DISTILLATION AND GAS RECOVERY UNIT 1.5×10^6 m^3/day

See Standard Module No. X1

MODULE NO. N23
CRUDE DISTILLATION UNITS/CRUDE DESALTING UNITS

Module area = 2.9 hectares: 240m x 120m

Process Input/Output:

Input to the module is from crude intermediate storage. Outputs go to gas recovery, naphtha, kerosene, gas oil, and residuum processing units.

A. CRUDE DISTILLATION UNIT 23,850 m^3/day

See Standard Unit No. X12

B. CRUDE DISTILLATION UNIT 6,360 m^3/day

See Standard Unit No. X32

C. TWO CRUDE DESALTING UNITS 6,400 m^3/day

See Standard Unit No. X33

MODULE NO. N24
MAINTENANCE SHOPS AND STOREHOUSE

Module area = 4.8 hectares: 396m x 120m

A. BUILDING

61m wide x 61m long x 11m high

MODULE NO. N25
WASTEWATER TREATMENT

Module area = 26.7 hectares: 636m x 420m

Process Input/Output:

Inputs to the module come from refinery sewer system. Output is discharged to receiving waters.

A. WASTEWATER TREATMENT PLANT 20,000 m^3/day

See Standard Unit No. X40

MODULE NO. N26
PRODUCT STORAGE

Module area = 29.8 hectares: 564m x 528m

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
6	motor gasoline	69	FR	76.2	14.6	66,581	836,015
3	motor gasoline	69	FR	51.8	14.6	30,787	350,920

MODULE NO. N27
FUTURE EXPANSION

Module area = 12.9 hectares: 564m x 228M

This area is reserved for future refinery expansion.

MODULE NO. N28
CRUDE OIL STORAGE

Module area = 21.7 hectares: 516m x 420m

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m3)
9	crude oil	28	FR	76.2	14.6	66,581	1,288,800

MODULE NO. N29
FEEDSTOCK STORAGE

Module area = 20.4 hectares: 516m x 396m

No.	Stock	RVP Estimate (kPa)	Tank Type	Dia (m)	Ht (m)	Capacity (m^3)	Annual Throughput (m^3)
1	Slurry oil	0.14	XR	32.0	14.6	11,742	152,646
1	Slurry oil	0.14	XR	51.8	14.6	30,787	400,231
1	FCC feed	0.14	XR	51.8	14.6	30,787	400,231
2	FCC gasoline	63.	FR	51.8	14.6	30,787	400,231
1	Nat'l gasoline	83.	FR	32.0	14.6	11,742	73,293
1	Reformer feed	39.	FR	51.8	14.6	30,787	400,231
1	Reformer feed	39	FR	25.9	14.6	7,692	100,000
1	Reformate	31.	FR	25.9	14.6	7,692	100,000
1	Naphtha	39.	FR	51.8	14.6	30,787	400,231
2	Slop oil	0.7	XR	19.8	12.2	3,757	48,841
1	Raffinate	69.	FR	51.8	14.6	30,769	400,231

MODULE NO. N30
ADMINISTRATION CENTER

Module area = 7.6 hectares: 636m x 120m

A. BUILDING

125m wide x 125m long x 18m high

MODULE NO. N31
FUTURE EXPANSION

Module area = 19.4 hectares: 540m x 360m

The area is reserved for future refinery expansion.

APPENDIX A
VAPOR PRESSURES OF VARIOUS STOCKS

RVP @ 37.8°C

Material	psia	kPa
Propylene	230	1,585
Propane	189	1,303
Iso-butane	73	503
Normal butane	51	352
Iso-pentane	20.5	141
Normal pentane	15.6	108
Motor gasoline (winter)	13.0	90
Light naphtha	12.2	84
Natural gasoline	12	83
Straight-run gasoline	10.8	74
Motor gasoline (summer)	10	69
Polymers	10	69
Cat gasoline	9.2	63
Aviation gasoline	6	42
Reformer feed stock	5.7	39
Heavy naphtha	5.7	39
Hexane	5.0	34
Alkylate	5.0	34
Spent caustic	5.0	34
Reformate	4.5	31
B-T feed	4.5	31

RVP @ 37.8^{o}C

Material	psia	kPa
Crude	2-6 (4avg.)	14-42 (28 avg.)
Benzene	3.3	23
Process Condensate	3.0	22
Jet fuel, JP-4	2.5	17
Light gas oil	1.5	10.4
Iso-Paraffin	1.2	8.3
Toluene	1.1	7.6
Furnace oil	0.9	6
Cycle oil	0.5	3.4
Xylene	0.5	3.4
Cumene	0.2	1.4
Jet fuel, commercial	0.2	1.4
Spray or weed oil	0.2	1.4
Thinner	0.2	1.4
Solvent	0.1	0.7
Kerosene	0.03	0.21
Distillate fuel oil	0.02	0.14
Diesel fuel	0.02	0.14
Heavy gas oil	0.02	0.14
Automotive diesel	0.02	0.14
Cutter stock	0.02	0.14
Light residuum	0.015	0.1
Lube oil	0.007	0.05
Heavy residuum	0.0001	0.0007
Residual fuel oil	0.0001	0.0007

APPENDIX B
ENGLISH - S.I. UNIT CONVERSIONS

SI Unit	English Equivalent
1 Kilogram (Kg)	2.2 Pounds
1 Metric ton	2,200 pounds
1 Gigajoule (GJ)	1055 x 10^6 BTU
1 Hectare	2.47 acres
1 Meter (m)	3.28 feet
1 Cubic meter (m^3)	264 gallons
1 Cubic meter (m^3)	6.29 barrels
1 Kilo pascal (kPa)	6.145 psia